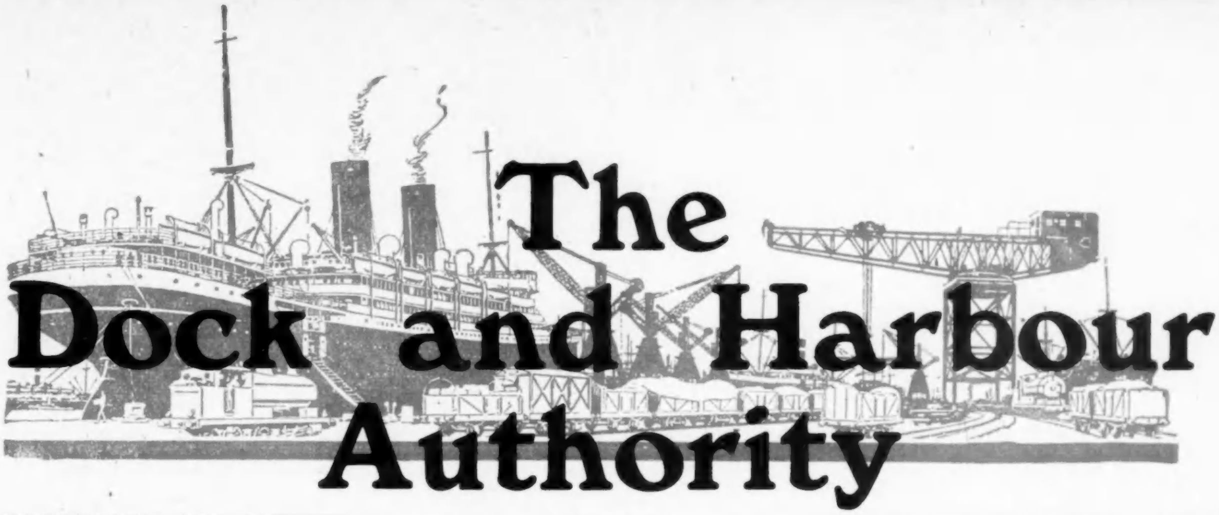


The Dock and Harbour Authority

No. 311. Vol. XXVII. SEPTEMBER, 1946

CONTENTS

Editorial Comments

The Port of Boston, Mass., U.S.A.

Boston, the capital of the State of Massachusetts, is one of the leading ports on the Western Coast of the Atlantic, and in addition to its commercial importance it is distinguished by interesting historical associations. From the fateful day in December, 1773, when the indignant citizens overturned cargoes of tea into the harbour waters in angry protest against paying Customs duties in the levying of which they had had no voice or representation, Boston has been in the forefront of American commercial enterprise. The city has made a name for itself, moreover, as a centre of culture and learning. It has a variety of local manufactures with products for export, but unfortunately for its prosperity as a port, they are generally of a light type and there is an absence of heavy material in bulk, such as grain, which plays so prominent a part in the shipments of its neighbouring competitors. This militates against its popularity with shipowners and charterers who prefer to serve ports which can provide " balanced cargoes," i.e., in which the volume of imports is matched more or less evenly with the volume of exports. It will be seen from the figures given in the article on the port in this issue that the weight of imports at Boston are several times as great as the weight of exports. This means that vessels have difficulty in securing full return cargoes. The cause of the disparity is due apparently to a differentiation in the railway rates charged for the transport of grain from the Western States to the ports along the New England coastline.

Whether this disability can be overcome remains to be seen, for with characteristic courage and energy the State has reconstituted its Port Authority on more modern lines and looks to the new body to take effective measures to bring the port into the forefront of American shipping enterprise. And in this it is to be hoped they will succeed. The port installations are such as to command admiration. There is a graving dock which ranks among the largest in the world, the great Commonwealth Pier, 1,200-ft. long by 400-ft. wide affording berthage simultaneously for five 600-ft. seagoing vessels, and an Army Supply Base, constructed during the first World War and now mainly devoted to commercial uses, which is one of the finest and most commodious storage depots in existence. Mention should also be made of the pre-eminence of Boston as a fishery centre. Its Fish Pier deals with huge catches of value unsurpassed in any country. There is, therefore, every prospect under the new regime of further advance in prosperity and influence.

Decasualisation of Dock Labour.

The problem of the decasualisation of dock labour, despite the fact that it has engaged the attention of the responsible authorities for a quarter-of-a-century, still continues to be a matter of serious concern, and the prospect of an early solution is not enhanced by the announcement in the press on the 21st ult. that the employers and the trade union leaders have jointly notified the Minister of Labour that they are unable to agree upon a suitable scheme.

As far back as 1920, the Shaw Report, after pointing out the evils of irregular and intermittent employment at the quayside, recommended that the principles of registration and maintenance should be adopted " in regard to all the labour employed at all the ports of the kingdom." In a large measure this has been done and during the late war the pressure of circumstances enabled a considerable number of men to be retained on the port registers, but, now that peace-time conditions prevail, a very appreciable proportion of them have become redundant, so that they constitute a heavy charge on the management funds of the National Dock Labour Corporation and the Ministry of Transport. It is stated that the average daily surplus of labour is more than 12,000 men and that the weekly deficits on the funds of the two bodies are £12,000 and £15,000 respectively. Such a state of affairs is too uneconomical to admit of its continuance, but though both sides are agreed on the necessity for a reduction in the number of men, there is a difference of opinion as to the method to be adopted in achieving it, as will be seen from the short summary of the situation by the Industrial Correspondent of *Lloyd's List* in their issue of August 22nd, which is reprinted on a subsequent page.

As regards the wider issue, as stated above, the employers and the trades unions concerned have been endeavouring to formulate a decasualisation scheme for which they have opportunity extending for another month. If a new scheme is not put into force by October 1st, the Minister is empowered to intervene with a scheme of his own, and, indeed, it seems likely that this course will be inevitable. The difficulties of the problem are only too obvious and it will require some considerable amount of tact and skill to devise a scheme which will be satisfactory to all parties. But the matter is of increasing urgency and no time should be lost in arriving at a solution. The subject has been frequently discussed in these columns, the last occasion being as recent as the August issue, in which a speech by Lord Ammon was reported and his call for a national policy commented upon.

Editorial Comments—continued

City of London Reconstruction Proposals.

The Committee for Improvements and Town Planning in respect of reconstruction in the City of London, recently submitted to the Court of Common Council an Interim Report prepared by the Joint Consultants, Dr. C. H. Holden and Pro. W. G. Holford. The Report recommends two stages of reconstruction and deals with office accommodation, traffic and road systems, housing, the wholesale food markets, the area surrounding St. Paul's Cathedral, open spaces, car parks and the Thames River frontage.

In their proposals regarding the last named, the joint consultants state that they have come to the conclusion that the river front, with its warehouses and wharves, is capable of great improvement, without curtailing its legitimate development for commerce associated with the river and with overseas trade. The suggested improvement will, at the same time, provide for access to the river by means of a terraced riverside walk on a setback in the warehouses at second floor height along the greater part of the front from Blackfriars to London Bridge. This riverside walk will be at a level that will not interfere with the loading and unloading of barges, with the exception of one strip of open space at wharf level, which would be accessible to the public. (This feature forms part of the plan for the St. Paul's precinct, and the essence of the scheme is that at one point on the front there should be an opening, pleasantly furnished and of some attraction in itself, giving a view of the river and its activities on the one side, and linking up by a footway with the Cathedral precinct on the other.)

Their proposal for the river front is put forward as a result of their conviction that the particular type of wharfing trade traditionally carried on between Blackfriars and London Bridge, on the north bank, is an essential element in the commercial life of the City, and that to plan this area out of existence by preventing the full exploitation of wharf frontage would be to kill rather than to cure. They would, however, like to see a more efficient use of the space between the river and Thames Street, and they are drawing up the skeleton of a scheme to show how warehouses and cold stores, on the lines of one or two recently built in the area, could be economically grouped and serviced, and in due course allow the public right of way to be carried through at the upper level. On such information as they have so far obtained, and from their own observations. they state, they are doubtful of the value of lagoons, or of wharves approached under an overhanging carriageway.

If the wharfingers as a whole were to move their business and change their methods to such an extent that they could all be accommodated much farther down-stream, the treatment of the river front in the City would take on an entirely different complexion. But if they are to plan to meet present needs and prospects, they feel that the problem must be grappled with on the spot; and that they must endeavour to point the way to a solution which combines utility with amenity, and gives an opportunity for good practical architecture, which will at the same time be impressive in its general effect when seen from the re-developed south bank.

Commenting on these proposals, the Improvements and Town Planning Committee state that they are not convinced of the feasibility of the construction of the proposed high-level riverside walk along the greater part of the front from Blackfriars to London Bridge—while recognising the amenity which would thus be provided for pedestrians and the architectural significance of terraced treatment rising from the river level. They have, therefore, asked the consultants to furnish them with detailed diagrams and a model of the treatment proposed for the riverside wharves and warehouses in order to achieve the project the consultants have in mind.

The Report, as presented, is essentially preliminary in nature and a great deal of work and much consultation has still to be undertaken before a definite plan is approved. Alternative proposals from other bodies, such as the London County Council, are likely to entail a number of modifications, and as far as the building line on the river front and access to wharves and piers is concerned, agreement will have to be obtained from the wharfingers, frontagers and the Port of London Authority.

At this stage therefore, no useful purpose will be served by making adverse criticism, but there is no disputing that some of the proposals are far-reaching, and we join the Improvements and Town Planning Committee in questioning their feasibility. As a basis for the Final Report however, the Consultants have put forward a comprehensive plan for the City of London which is worthy of careful study.

As the River front, the City wharves and also the traffic emanating from Thames-side industries and docks have a direct bearing on the commercial life of the City, the subject is of much interest, and we hope to refer to the matter in greater detail in a subsequent issue.

The Mulberry Harbour Model Tests.

Despite its many horrors and repulsive features, war in some of its aspects, may be of undoubted benefit to mankind, notably in the impetus which it gives to the invention and development of appliances and instruments of utility, intended primarily, no doubt, for purposes of destruction, but capable of being adapted to peaceful ends. An illustration of this truth is afforded by the model experiments carried out in connection with the Mulberry invasion harbour on the shores of Normandy, and described in a Paper by Dr. F. H. Todd, read recently before the Institution of Naval Architects, which is reviewed in this issue. The design and manipulation of floating caissons for the formation of harbour protection works is, of course, no new thing, having been practised in the distant past, as exemplified at Zeebrugge in Belgium, where the breakwater at the entrance to the port was created in this way half a century ago. But the complex difficulties of applying the method to the problem of the Normandy landings necessitated a closer investigation of the conditions and a finer determination of the features of the design than had previously been attempted. The data furnished by the experiments with the Mulberry models have not merely been of service to the special operation for which they were made, but they will also be a valuable guide in the future design of harbour works, in which advantage is taken of the convenient adaptability of floating caissons for the formation of breakwaters. There are other directions in which the data provided by the model experiments may be utilised and our readers will, no doubt, find scope for reflection on the subject after perusal of the article in question.

There were some notable differences in size and conditions between the Zeebrugge caissons and those which formed the subject of the recent experimental tests. The Zeebrugge structure was formed of units 82-ft. long and approximately 24-ft. by 24-ft. cross section. As they were intended to be permanent work, alignment had to be effected with some degree of nicety, whereas it was not so important a consideration on the Normandy beaches for the temporary protection desired. In both cases, however, the problems of transport and sinkage were similar and the knowledge gained from the model experiments will prove a valuable addition to that which was obtained in earlier experience.

Submerged Obstacles to Navigation.

One of the most anxious and imperative duties devolving upon port and harbour authorities at the present time, as an essential prelude to the free and unrestricted use of their waters is the removal, now being carried out in this country in conjunction with the Salvage Section of the Admiralty, of the great volume of wreckage which has accumulated in the fairways and entrances of the ports. The danger to shipping arising from this and other obstructions is such as to necessitate the utmost care in guaranteeing their complete removal, as is evident from the recent tragic loss of a tender belonging to the Mersey Docks and Harbour Board, which was blown up by an undetected mine, with the loss of several lives. Sunken wreckage is a no less insidious danger, liable as it is to tear holes in the undersides of craft, to foul anchorages and fishing nets, and even to cause silting in a navigable channel. The use of depth charges is stated to be proving efficacious in dispersing such wreckage. The method has to be followed by careful and systematic soundings.

Photo] [American Airlines
Aerial View of Boston Harbour, taken from a point above the Charles River Basin. The Main Ship Channel is in the centre and on the right background are Commonwealth Pier, operated by the Port of Boston Authority, the Army Base and the famous Fish Pier. On the left background are the Boston and Albany Piers and beyond, the Logan International Airport. Since this view was taken, the airport has been extended to Governor's Island on the right centre.

The Port of Boston, U.S.A.

Gateway to Massachusetts

By JOHN J. SPENCER
Director of Public Relations, Port of Boston Authority.

A great post-war project set before the State of Massachusetts is the restoration and full development of the Port of Boston, which is the gateway to the State and to all New England. Unless steps are taken at once to provide additional modern facilities at the port, Massachusetts—and in fact all New England will be under a serious disadvantage in the coming commercial rivalry.

There now are only 29 berths at the port capable of handling large ships carrying general cargo, as compared with 35 before the war. Of the present number, however, some are obsolete and need to be replaced by facilities that can handle modern ships, which are about one-third larger than the pre-war models. Even if all these were adequate in their present condition, the port would find it difficult to handle business at the pre-war level. Should there be a marked increase in trade in the post-war period as is expected, if immediate steps are not taken, Massachusetts will have lost an opportunity that may vitally handicap this region for decades to come. Furthermore, the port has suffered by the lack of any strong authoritative central organisation to manage its affairs on a business-like basis.

Act Relative to the Development of the Port of Boston, S. 216, H 684

The above Act provides for a minimum number of modern piers to meet the emergency situation and for a reorganised Port Authority, under the jurisdiction of the Commonwealth of Massachusets with adequate powers to operate, construct, lease and co-ordinate all interests into a strong organisation capable of rendering prompt and efficient service in competition with all other ports. In order to provide funds for the purchase of property and for the construction thereon of suitable piers, deemed necessary for the post-war development of the port, the Bills provide that the Legislature shall appropriate 15,000,000 dollars by the issue of bonds.

The Commonwealth of Massachusetts should be vitally interested in the Port of Boston because it is the gateway to Massachusetts commerce, and as such provides cheap transportation for its principal industries. The conversion of raw materials into finished manufactured goods constitutes the mainspring of industrial activity in Massachusetts and provides work for the vast majority of our people. Practically all of our raw materials and fuel and the bulk of our food, must be imported from other regions of the country and from all parts of the world. Hence, transportation plays a most vital role in our economy. Most of the major industries in Massachusetts were established here because of cheap water transportation, and their survival is dependent upon adequate modern facilities which would attract ships plying the trade routes of the world. The Commonwealth has already invested nearly 26,000,000 dollars in the development of the port, and should be concerned about protecting this investment to such an extent that it may eventually pay its own way.

The New Port Authority

The Port Authority is the vital element which will bring about the rebuilding of the Port of Boston and restore it to its ersewhile position among the ports of the world.

Although thwarted for the last 15 years by public and official apathy, the Port Authority has at last, by action of the General Court of 1945, been granted the power and the funds to begin the long-delayed work of reconstruction.

The Port of Boston, U.S.A.—continued

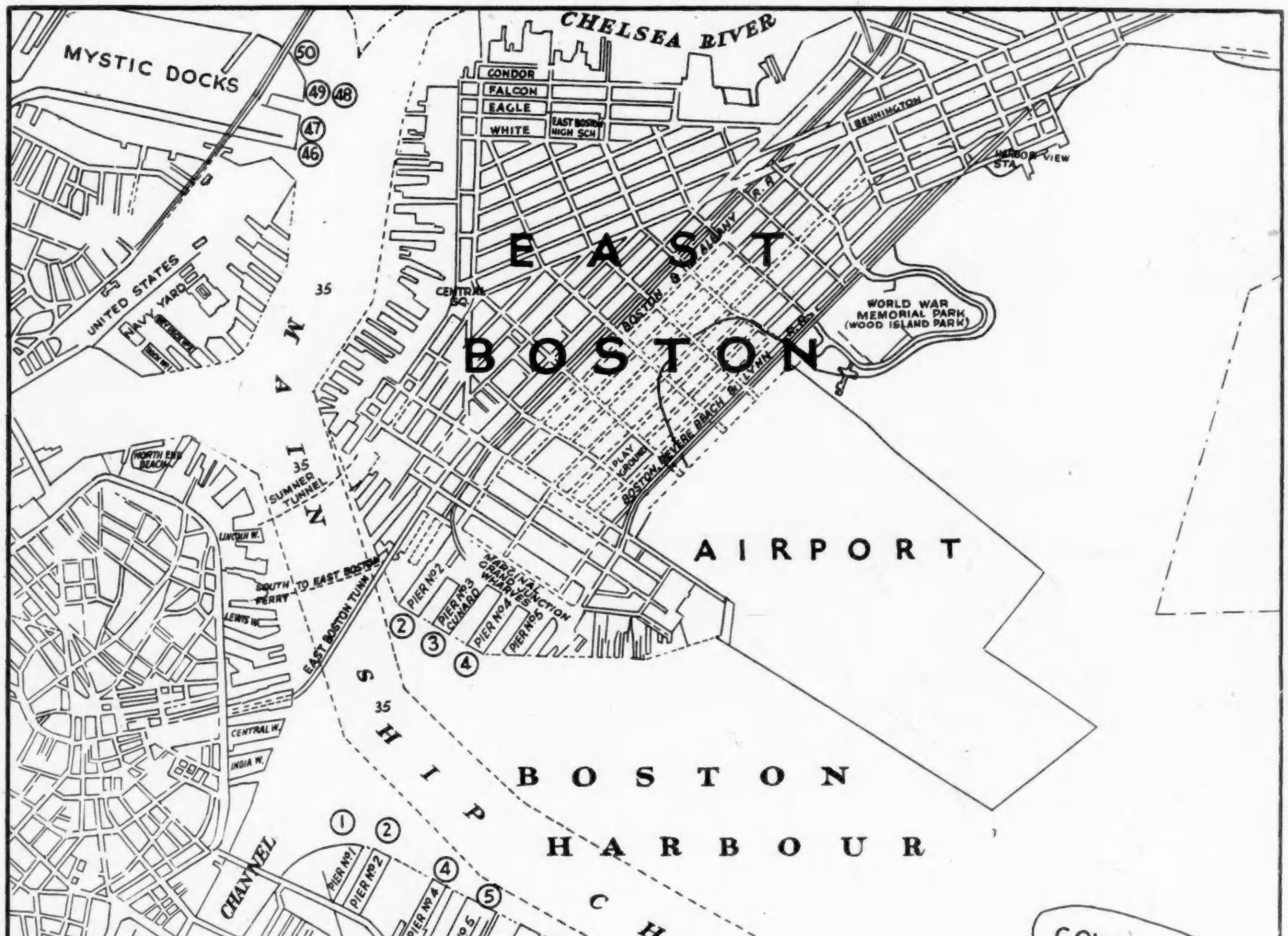
Accepting in large part the recommendations of the Lane-Paterson report, prepared by Andrew F. Lane, late manager of the old Boston Port Authority and Assistant Director of the new Authority, and Nicholas E. Peterson, the General Court reconstituted the old group as the Port of Boston Authority, made it a State Department, transferred to it complete powers over the harbour and made available to it 15,000,000 dollars to begin its work.

During its years of pleading and suggesting, the old board had seen to it that comprehensive studies of the needs of the port were made. The Lane-Peterson report had recommended the acquisition of the Hoosac Piers of the Boston and Main railroad at Charlestown, where five docks had been razed.

The new Authority, at its first meeting, began this work and has recently prepared plans for a 6 to 8 million dollar pier, with a grain elevator and berths for four modern ships.

The new Hoosac Pier and grain elevator, costing $5,000,000 will be of the most modern construction and is suitably located for both coastwise and foreign shipping. The new pier will be leased to a responsible lessee on terms which will amortize 60 per cent. of the cost in a twenty-year period.

The proposed next step in the rebuilding is the acquisition of the Mystic Piers 46-50 at Charlestown, where Pier 46 will be replaced with a modern pier with berths for three large ships. The sum of $4,700,000 is already available for this work through action in 1941, but increased labour and material costs have made it



The Port of Boston, U.S.A.—*continued*

necessary for the Authority to submit to this year's General Court a request for an additional $1,300,000.

The Port Authority, under the leadership of Judge James R. Nolen, Chairman, recently secured an interim permit to operate commercially the great army-built terminal at Castle Island and is conducting negotiations with the War Assets Corporation for final title. Construction of these berths was recommended to the Army in 1941 by Richard Parkhurst, member of the United States Maritime Commission, who was then vice-chairman of the Old Boston Port Authority.

Present Port Facilities

Boston Harbour includes all the tide water lying within a line from Point Allerton, Hull, to Point Shirley, Winthrop, comprising an area of about 47 sq. miles, exclusive of islands. The water frontage of the port is over 140 miles, of which some 7 miles has a depth of 35-ft. or more at mean low water.

The jurisdiction of the new Port Authority extends over this area, and includes the Weymouth Fore and Back Rivers, Mystic River, Chelsea Creek, Island End River, Town River, Weymouth, Fort Point Channel and Charles River.

Under the direct jurisdiction of the Port Authority is Commonwealth Pier No. 5, with a 40-ft. depth and five berths, which can handle four large cargo ships at one time. The Port Authority also has control of Commonwealth Pier No. 1, which was turned over to the Navy and has not as yet been returned. It is suitable for coastwise shipping.

The Commonwealth, through the Port Authority, is also owner of the huge Fish Pier, where the annual value of the catch is the highest in the world. This pier is under lease to a fishing association, who erected the freezers, ice plants, stores and administration buildings located on it.

Other existing facilities suitable for general cargo operations are the Boston and Albany Piers at East Boston, with five berths and a depth of 35-ft. at mean low water. These piers cover an area of some 44 acres and are familiar to many travellers from the United Kingdom, since the Cunard liners have docked there for many years. A grain elevator is connected with the piers by conveyors. It is a fireproof, steel structure and has a capacity of 1,100,000 bushels. These piers are also equipped with commodious and modern fireproof warehouses, and are connected with the main line of the New York Central Railroad (B. and A. District) by the Grand Junction branch running directly to the piers.

Located in Charlestown are the Hoosac and Mystic Terminals, owned by the Boston and Maine railroad. Pier 41, at Hoosac Docks, the site of the Port Authority's first building project, at present is used only for the loading of grain vessels. The grain elevator has a capacity of 1,000,000 bushels and has galleries to Pier 41 and to Piers 46 to 50. Mystic Docks, part of which may be rebuilt by the Port Authority at a cost of $6,000,000, has six berths with a depth of 30-ft. at mean low water, and a grain elevator with a capacity of 500,000 bushels with galleries to Piers 48-49 and 50.

North and South Pier Sheds, Army Base, with Castle Island in Background across the Reserved Channel.

An open dock at Mystic River is equipped with two cranes with magnets for handling steel or scrap iron direct from cars, and slings for handling pulp wood or other commodities direct to open-top cars. At the coal discharging plant, Mystic River, the bulk handling plant is equipped with five modern towers for discharging coal, ore, sulphur, nitrates and other bulk commodities direct from ship to open-top cars. From these terminals, the Boston and Maine railroad has rail connections to all parts of the United States and Canada.

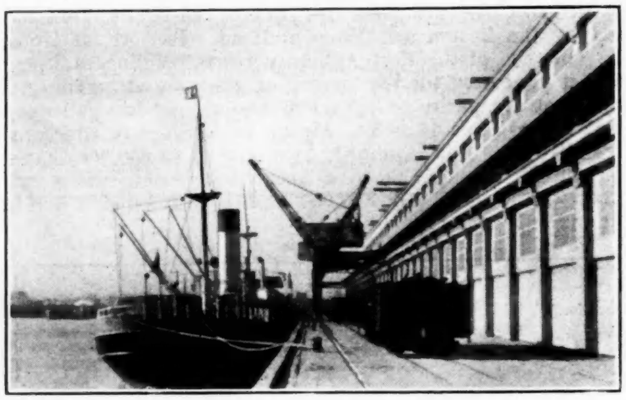
The Army Base, with nine berths, has been restored to commercial operation after a notable war-time record, during which hundreds of thousands of soldiers and millions of tons of supplies were sent to Europe. Across the Reserved Channel, are the new Castle Island berths, built in the early days of this war and also under the supervision of the Army. These berths will also be used for commercial operations.

Castle Island has 4,000 lineal feet of quay-type berthing space, with berths for seven ships. Not all of these are at present suitable for general cargo operations, but plans for their revision are under consideration.

In connection with Castle Island and the Army Base, the officer who presided over their huge activities as commandant of the Port of Embarkation, Major-General Clarence H. Kells, U.S.A., now retired, has joined the Port Authority as director.

The Port of Boston, U.S.A.—*continued*

Following his service here which lasted until the closing days of the war in Europe, General Kells was transferred to the San Francisco P.O.E., where he supervised the activities until the end of the war in the Pacific. He later was assigned to New York, where he handled the great task of arranging for the return of millions of American service men.



Army Base Terminal, Boston.

The Port of Boston has ample warehouse space for commodities of every kind. Ship repair and refitting services are available, with splendid dry dock facilities. Railroad yards are capable of handling more than 4,000 freight cars at once, without interfering with ordinary domestic rail movement of freight and passengers.

In recent weeks, there has been a substantial increase in ocean passenger and cargo service by lines which served the port in pre-war days. Notice has been received from other lines that they intend to resume service as soon as ships are available.

Boston is the port which affords the shortest through route between Europe and the interior of the United States and Canada.

Its principal imports are fruit and nuts, gunnies, jute, hemp and sisal, cotton and logs, crude and reduced oil, rubber, sugar, wool, wood pulp, iron ore, cement and gypsum.

Exports consist chiefly of grain, flour, cotton waste, textiles, fertilisers, apples, lard and tallow, leather and manufactures of leather, machinery, provisions and meats, paper and manufactures of paper, scrap metals and high-class manufactured products.

There is every indication of a great increase of traffic through the port, which in 1940, the last year of normal traffic, handled 19,018,305 tons of cargo. In tons of 2,000 pounds, this was divided as follows:—

Foreign Trade, imports, 2,280,851 tons; exports, 455,474 tons.

Domestic Trade, coastwise receipts, 14,657,840 tons; coastwise shipments, 1,624,240 tons.

The Port of Boston is at present in something of the same situation as that faced by London about 1900, when a Royal Commission found docks in need of rebuilding and port facilities long neglected. An overall authority was appointed to take charge and soon the Port of London was supreme as a world shipping centre. The new Port of Boston Authority is confident that it can do the same for the historic port it supervises.

Difficulties of a Decasualisation Scheme for Dock Labour

In an article in *Lloyd's List* on August 22nd, the Industrial Correspondent of that Journal made the following comments on the points at issue between the Employers' and the Men's representatives:

The announcement that representatives of both sides of the National Joint Council for the Port Transport Industry had seen the Minister of Labour can be taken as an indication that no joint agreement has yet been reached in regard to a new permanent scheme of decasualisation for dock workers to take the place of the present war-time arrangements.

The employers' organisation and the trades unions' representatives have been for some time endeavouring to draw up a new permanent scheme which will be acceptable to both sides of the industry, and it was hoped that such a scheme might have been prepared by the end of this month, ready to be put into operation by October 1st next. Under the Dock Workers (Regulation of Employment) Act, if a new scheme is not in force by October 1st, the Minister of Labour, on the joint application of the industry, may prepare such a scheme, while if, at any time after October 1st, no such scheme is in force, the Minister may prepare a scheme if it seems unlikely that any joint scheme will be forthcoming.

The present position is that the Minister has undertaken to conduct an enquiry into the points of difference between the two sides in the event of the discussions breaking down, and if no agreement is reached by the end of the month it is likely that such an enquiry will be held. In any event, a new scheme for the dock labour industry, to replace the present war-time schemes, must be put into operation by July 1st, 1947.

Question of Control

One of the main point of difference between the two sides is over the question of control—whether it should be joint control or otherwise. The unions' view is that there should be a joint control of administration, which would include joint control of the size of the register; the employers say that while all industrial matters should be dealt with jointly as hitherto, the question of administration should be a separate matter. In particular they would not agree to joint control of the size of the register.

A further cause difference is in regard to the form, shape and amount of the guarantee to be given to the workers. The unions are pressing for a weekly guarantee, and also for attendance money to be paid for each half-day of unemployment. The employers favour a periodical guarantee and say that attendance money is inconsistent with any system of guarantee.

Surplus of Labour

There is joint agreement between the two sides that there is a redundancy of port labour, but disagreement as to the best method of reducing the surplus, which is very heavy. The unions' view is that men in the industry at the outbreak of war should not be affected by any dismissals, but the employers, while agreeing that the older men should receive preferential consideration (subject to their being reasonably capable of work), contend that such a barrier cannot be allowed to remain if the problem of redundancy is to be tackled properly. At the present time, the dock labour industry is carrying a large number of men who are, by reason of age or capacity, only partially effective, and the unions are asking that all the older men who might be retired from the industry should be given a special industrial pension. This the employers are not prepared to give, holding the view that it would be supplementary to the State pension. At the same time, it should be pointed out that the question of redundancy is not confined to the older men, for it applies throughout the industry.

Port of Limerick Development Plans.

The Limerick Harbour Board is considering a scheme for the development and further extension of the city's port facilities. The plan provides for a new western entrance and approach channel, the building of training walls for a distance of about 9 miles down the Shannon to provide a deeper and more navigable channel, the erection of a deep water wharf, and considerable dredging of the river, the connecting of the docks with the railway and the improvement of the present link with the canal.

Marine Slipways

Their Range of Usefulness and Efficiency

By W. GORDON GLOVER, M.I.Mech.E., M.I.N.A.

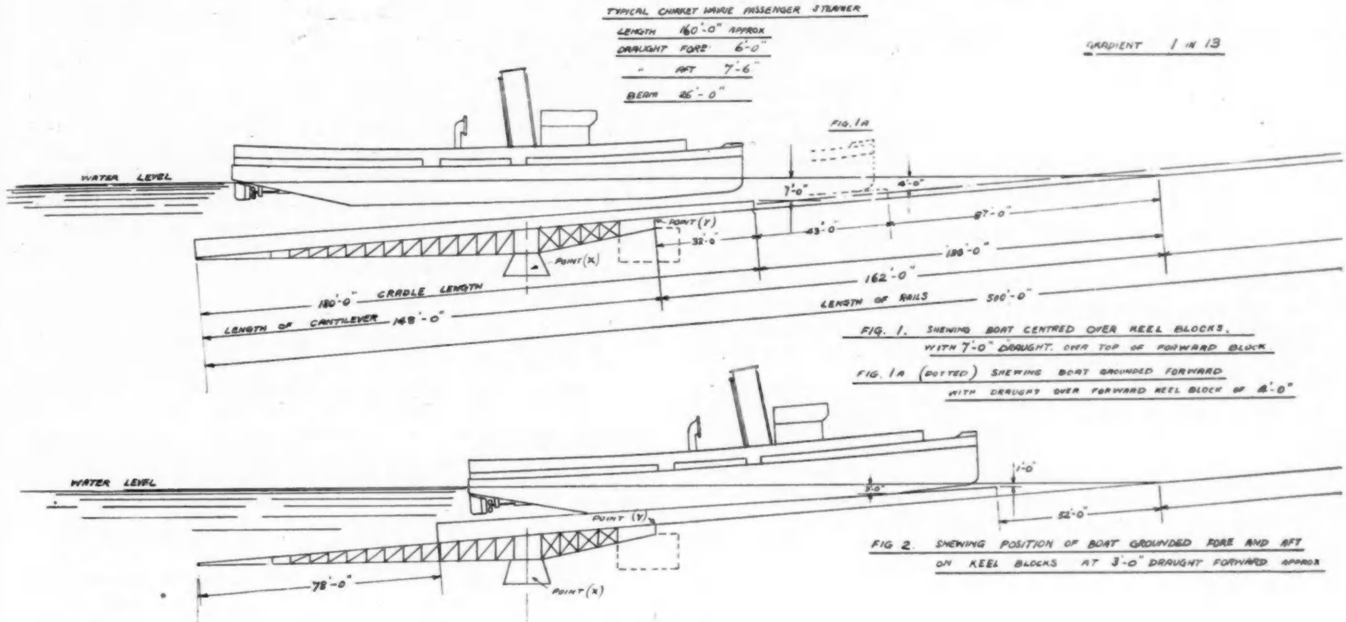


Fig. 1.

THE devastation wrought by the world war has robbed many seaports at home and abroad of their docking facilities, with the result that there exists a shortage of accommodation for the repair of ships which must be made good if the volume of merchant shipping of all classes now under construction is to be efficiently coped with.

It is in this connection that there would appear to be open a wide field for the most adaptable and economical of all docking appliances, the Marine Slipway.

While, as has been stated by Mr. R. R. Minikin in his recent interesting article on slipways*, the range of efficiency of the slipway is somewhat limited and while there are, admittedly, many ingenious equipments in existence for multiple slipping of small craft up to the tonnage mentioned, both side-slipping and radial, the following is an endeavour to bring to the notice of dock authorities and enterprising ship repairing firms the fact that, by adhering to British methods, this range may be greatly widened and slipways of at least equal capacity to those known to be in existence in the U.S.A. can be constructed on efficient and economical lines.

It is true that, up to the present, the Crandall Engineering Co., of Boston, U.S.A., by using the principles of their railway dry docks or marine railways have surpassed in capacity any slipway which has been constructed on British methods. They have installed equipments capable of handling vessels up to 8-10,000 tons. This was rendered possible by their adoption of the Live Roller System as against the Truck and Carriage or Wheel and Bearing System more generally preferred in this country. The Live Roller System has certain advantages, notably the reduction of friction to a minimum, with its corresponding reduction in horse power and the fact that the heavy load is distributed over the bodies of the rollers and not on the axles and bearings as in the case of the other system. Counter to these advantages, however, there emerges the point that one of the fundamental principles of the railway dock is that it is not hauled completely out of the water owing to the very high build-up at the after end. While this provides virtually a horizontal floor to the dock above water level it renders both roller paths and roller frame inaccessible for examination and repair if necessary between dockings, a considerable portion of both being always submerged. It is largely for this reason that, in this country, the fundamental principles laid down by Thomas Morton* have been so closely adhered to, even in the most modern equipments.

As an alternative to the Wheel and Bearing System, there is, of course, that of fixed axles with wheels, bushed with gun-metal, running free thereon. Although the question of bearing pressure again arises in this system, it has certain advantages, notably a considerable reduction in the height of cradle structure, a great saving in casting weight by the absence of cast iron or cast steel bearing brackets and simplicity of lubrication. The system has been used efficiently in a number of instances and where circumstances warrant, is recommended.

It is generally supposed that the slipway ceases to be an efficient and economical means of rendering a ship's hull accessible for repair beyond an approximate limit of about 1,000/1,500 tons, whereas there are in existence to-day many installations of from 2,000 to 4,000 tons capacity which are more efficient and more economical to work than dry docks or floating docks of equal capacity. There is, in fact, under consideration at the present time, the construction of a slipway of 4,250 tons capacity for the Far East and there is no reason to suppose that this or even 5,000 tons is the limit on the Wheel and Bearing System. There is, however, a limit to the all-important matter of axle bearing pressure which the designer must take into account when considering the heavy local loads which arise when handling a ship with extensive bottom damage or at the point of full sue. In this last connection, careful thought should be given to the inclination of the keel block line, with a view to reducing to a minimum the period of sue.

*The Dock and Harbour Authority, December 1945.

*Thomas Morton was the Patentee of the Invention known as "Morton's Patent Slip," by Royal Letters Patent dated early in 19th Century.

Marine Slipways—continued

Foundations

It is here that enters the all-important matter of the foundations which, in dealing with ships above a certain tonnage, require the closest study and careful selection by the Civil Engineer of the most suitable form of construction compatible with the nature of the foreshore at the site selected. The most common form of construction is by piling, using timber or concrete piles as the case may warrant, connected by cross ties, and with timber, reinforced concrete, or steel longitudinal way-beams, constituting the mid and sideway tracks.

As ships of the trawler class, deep sea tugs, etc., are generally built with a bar keel and, it may be said, all merchant ships have a slight rise of floor, the foundations should take into account the fact that the entire weight of the ship must be carried by the centre track and, under normal conditions, 15/17½% of the total weight by each of the side tracks.

In a longitudinal sense, special attention should also be paid to the period of sue, an approximation of which can be arrived at by means of a load diagram such as is illustrated in Fig. 4 of Mr. Minikin's article. Here, what may be considered as a heavy and concentrated travelling load is encountered over a certain range of track, to cope with which, the foundations should be proportionately reinforced.

In many cases, where the nature of the foreshore permits, it has been possible to dispense with piling and make use of the mattress form of construction, either by employing an apron of concrete or by a system of sleepering. A good example of this, within the writer's experience, is that of the slipways of Basrah, Mesopotamia, built during the 1914-18 war. Here the ground was far from that which could be desired, the incline being entirely made up of soil derived from the excavation of a basin at the back of the "dump." It was decided to dispense with piling and, in spite of the fact that the foundation over the length of sue consisted of virtually a mattress of heavy timber cross sleepers, due to the spongy nature of the ground, especially in the rainy season, subsidence took place and it became necessary to make up the track periodically over this range. It may be said in this connection, however, that although the slipways were designed for 550 tons, ships up to 900 tons were frequently handled.

A somewhat awkward condition is sometimes encountered where the foreshore has a normal declivity for a short distance below water level and then takes a sudden sharp drop into deep water. Such was the condition pertaining on the Golden Horn, Constantinople (Istanbul), and was overcome by the construction of a cantilever girder to form the lower portion of the track, placed at the outer end of ample length to carry the rails to the requisite depth.

Fig. 1 illustrates this method which was carried out very successfully.

While doubtless initial expenditure in the construction of foundations can be kept down by the use of such methods as mattress construction, etc., they frequently prove to be false economy in the long run as they tend to produce high maintenance costs, and the risk of subsidence taking place while handling a valuable ship on the slipway should be avoided at all costs and this can only be done by the provision of ample margin in foundation construction.

Equipment

Of equal importance to the foundations where the safe handling of ships is concerned, is the equipment, rails and upwards. Here there have been few departures from Morton's principles.

Upon the system to be adopted for the cradle, wheel and bearing or live roller, depends the nature of the track, rails or roller paths. In the early days, it is noticeable that the rails were in the majority of cases of cast iron, those for the midway or centre double track being cast in one piece with the rack, in short sections of about 10-ft. Rails were usually wide on the tread, up to 6-in. in certain cases, with a view to obtaining a long line contact. The rails were laid as black castings and seldom, if ever, machined on the tread, thus producing an unevenness of surface due to bad butt joints, hogged castings, etc.

In modern practice the tendency has been towards the use of rolled steel rails of F.B. section of which, prior to the war, there was a wide range of selection, some very fine sections being obtainable from Germany. These were obtainable up to about 101.75 Kgs. per metre or 204.4 lbs. per yard and could be laid in lengths of about 40-ft., the cast iron paul rack being independent and laid centrally between the twin rails forming the midway track. It is considered that rolled steel rails of this heavy type would be capable of dealing with the maximum loads which might be encountered in a slipway of the largest possible capacity.

Where the live roller system is favoured, as in the U.S.A., the roller paths usually consist of timber way-beams with either a series of heavy steel plates equal in width to that of the way-beams spiked to the surface thereof, or a number of heavy steel flats 4-in. to 5-in. wide, laid parallel throughout the length of roller paths. It is not thought that this method would be generally considered in this country due to the tendency of the plates or flats to turn up at the butts, although there are various methods whereby this can be prevented.

Two good examples of live roller slipways are those, each of 1,000 tons capacity, at Port Said, built a number of years ago for La Compagnie Universelle du Canal Maritime de Suez. Here special attention was paid to the roller paths which were of cast steel with machined surface, the centre path being 2-ft. and the sides 1-ft. in width. The rollers were also of cast steel, double flanged, but in the writer's opinion, too small in diameter being only 4-in.

The cradles were specially designed for the handling of dredgers, hoppers, etc.

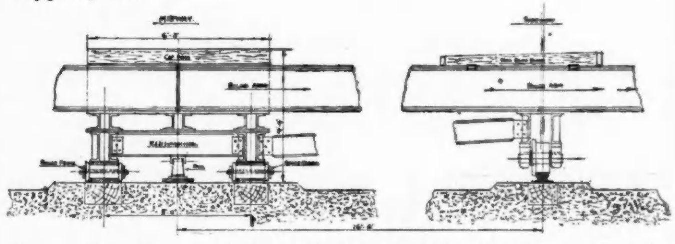


Fig. 2. Part Section of Cradle showing Combination of Systems. Live Roller (Midway) and Wheel Bearing (Sideways).

As previously stated, by the use of the Live Roller System slipways can be installed of greater capacity than by the generally adopted British method. There is, however, no reason why, by a combination of both systems, i.e., live roller on the centre track and wheel and bearing on the side tracks, the capacity of slipways on British principles could not be greatly increased.

This system is illustrated in Fig. 2.

By this means, it is considered that the heavy central load, the actual weight of the ship distributed, could be efficiently dealt with by the central roller path and the requisite bilge support by the normal wheel and bearing system. In putting forward this suggestion, it is not proposed to utilise the principles of the railway dock, but to adhere to the British method of hauling the vessel entirely clear of the water. Even so, there still exists the disadvantage of a considerable portion of the roller frame of the centre track being permanently submerged and, therefore, inaccessible for ready examination and repair. The point here to be considered is whether the increased capacity obtained by such a method, outweighs the disadvantage referred to. This is a moot point.

Reverting to prevalent British methods, there is no reason to doubt that, given ample length on the landward side and by merely duplicating the centre track by providing 4 lines of rails instead of 2, or even by providing 3 centre rails, the axle bearing pressure can be brought down to a very low level, thus making it possible for ships of 8-10,000 tons displacement weight to be handled on the longitudinal system.

Cradle

As is well-known, there are various types of cradle designed to suit different conditions, of both steel and timber construction, the most economical in initial cost being the Telescopic Type,

Marine Slipways—continued

whereby the track is shortened and a considerable saving in underwater construction can be effected. With careful design, moreover, and due consideration being given to lengths, number and combinations of the various sections, ships up to 2,500 tons light displacement weight can be handled with safety and efficiency.

One of the best examples of this type of Cradle is that existing in Kilindini, Mombasa, the property of the African Marine and General Engineering Co., Mombasa, where, instead of the sections being coupled by chains or wire spans, rigid steel drawbars of special design are employed. These, running smoothly on rollers, are housed inside the midway girders of the cradle, in which various pin stops are arranged in order to provide lengths of span of 5, 10, 15 or 20-ft., as may be required for different combinations of the sections.

In this case, the Cradle is divided into 5 sections, as follows:—

Section No. 1	24-ft. 6-in.	in length
Section No. 2	24-ft. 6 in.	in length
Section No. 3	88-ft. 0-in.	consisting of 3 sub-sections, 3 (A), 3 (B) and 3 (C), each
	28-ft. 8-in.	in length
Section No. 4	24-ft. 6-in.	in length
Section No. 5	24-ft. 6-in.	in length
Couplings	6-ft. 0-in.	in length
	190-ft. 0-in.	collapsed length

While provision is made for a maximum expansion of 300-ft., this is seldom, if ever, used, the collapsed length of 190-ft. being capable of dealing with Coasters of 1,000-1,200 tons and with extended length of 260-ft., vessels up to 2,500 tons. Fig. 3 shows alternative combinations for this purpose.

When dealing with vessels in excess of 2,500 tons, it is considered advisable to adopt, as in the past, the rigid type of cradle or, as is more convenient and more general in recent designs, the semi-rigid type in which a series of close coupled sections are employed.

To render more scope to this last-mentioned type, it is good practice to divide the cradle into two portions by placing the balance pulley and haulage attachment between the two, instead of the forward end. By this means it is possible to deal, not only with vessels of the maximum size for which the slipway has been designed, but two or more small craft independently.

The scope and usefulness of this type of Cradle may be increased by sub-dividing the two main portions into sections of convenient lengths. This method has been adopted with the greatest success in the case of an equipment of 3,000 tons capacity at Kowloon, Hong Kong. Here the Cradle consists of three main sections each 100-ft. in length with a keel block line, 300-ft. in length, rising uniformly from a height above rail base of 4-ft. forward to 7-ft. aft.

The haulage attachment is set between the two after main sections, thus the two forward sections are propelled and the rear section hauled, as illustrated in Fig. 4.

The three main sections are sub-divided as follows:—

Section No. 1 into 3 Sub-Sections, Nos 1 (A), 1 (B) and 1 (C)
Section No. 2 into 2 Sub-Sections, Nos. 2 (A) and 2 (B)
Section No. 3 into 3 Sub-Sections, Nos. 3 (A), 3 (B) and 3 (C)

Given eight sections, therefore, in a cradle of 300-ft. in length and utilising the various combinations of these, the equipment is capable of dealing with the following:—

(1) One vessel of 320-ft. in length up to 3,000 tons displt.
(2) One vessel of 200-ft. in length on Sections 1 and 2, with pawls dropped, leaving Section 3 free for a second vessel up to 100-ft. in length.
(3) One vessel of 100-ft. in length on Section 1, pawls dropped, leaving Sections Nos. 2 and 3 available, alternatively, for one vessel of 200-ft. in length or for two vessels of from 90-100-ft., either separately or together.
(4) By utilising various combinations of the Sub-Sections a a variety of small craft may be handled and for this purpose, alternative positions of bilge arms are provided on Sections Nos. 1 and 3.

In this cradle a departure from the generally accepted form of

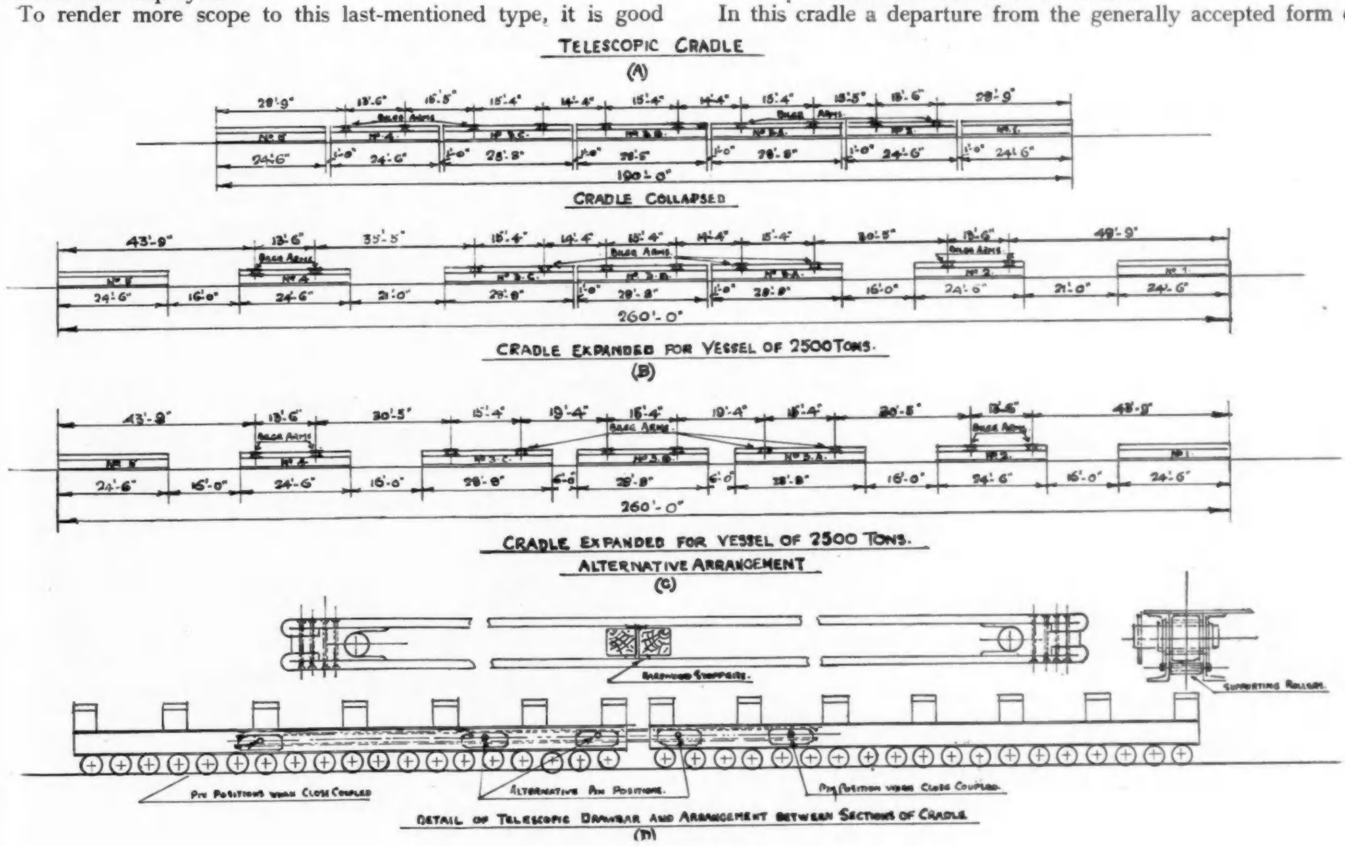


Fig. 3.

Marine Slipways—continued

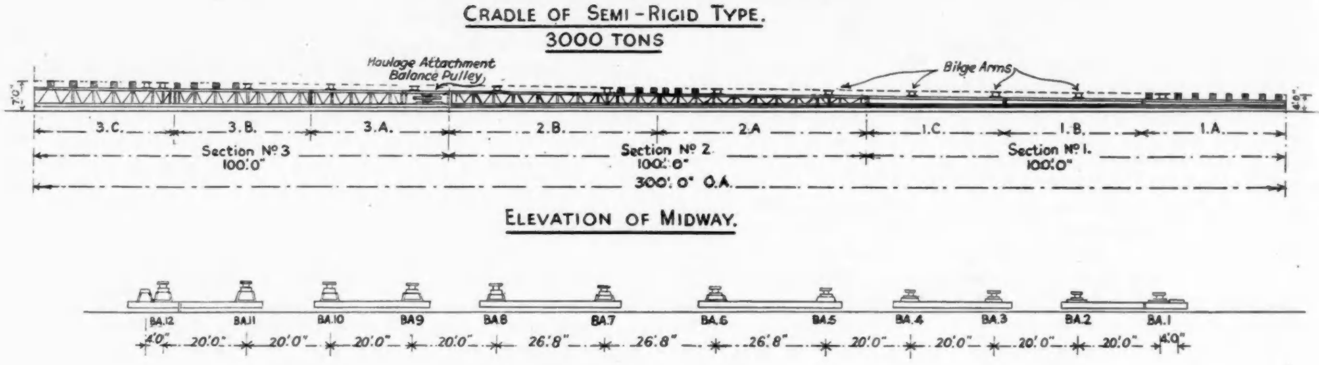


Fig. 4.

construction is also made, in so much as Section No. 1 is of tapered plate and angle construction while Sections Nos. 2 and 3 are of open lattice design, all increasing uniformly in depth from forward to aft, thus leaving the keel blocks of uniform height throughout. This form of construction is most advantageous from the point of view of maintenance, access for painting, etc. A considerable saving in weight of material may also be effected.

Special attention has been given in this design to the easy coupling and uncoupling of the various sections and the distribution of rollers to cope with the varying loads.

The incline of the track is 1 in 20 with an overall length of 860-ft.

The haulage gear is of the double drum, double purchase type, giving a four-part wire rope haulage system, driven by two motors, each of 130 b.h.p., with geared downhaul drum controlled by friction clutch.

Given, therefore, the advantages of the different methods of track and cradle design, as referred to above and given also sufficient length in a longitudinal sense, it would appear that no great difficulty need be experienced in the design and construction of slipways, on purely British principles, which would greatly exceed any such in existence at the present time.

In cases where a cradle of the rigid or semi-rigid type is used and particularly when dealing with a class of vessel having a somewhat high rise of floor, a great saving in time and man-power can be effected by the use of a system of hydraulically operated bilge blocks.

The whole system of operation may be self-contained in the cradle, advantage being taken of the pull exerted by the wire ropes at the drawbar which is released over a limited period and applied to a pair of compressor rams, fitted at the fore end of the midway of the cradle. By a simple line of piping through the cradle, the pressure (hydraulic), is conveyed to a cylinder formed in the cast wedge-shaped base of each bilge block, forcing the same forward and, by so doing, raising the articulated bolsters mounted on a slipper on the inclined face of the wedge, into contact with the hull.

It should be noted that hydraulic pressure is used only to effect this contact which is thereafter positively maintained by mechanical means. It will be seen, therefore, that the pressure of application being uniform and controlled, the possibility of bad dockings is obviated. The bolsters, moreover, being articulated, conform to the contour of the hull whether concave or convex due to damage. The whole operation of blocking a vessel on a slipway may be controlled by a trip line from one or other of the jetties bordering the slipway. No previous preparation of bilge blocks is required.

As an alternative to the longitudinal type of slipway is, of course, that of broadside. This, however, is more adaptable for and more frequently used in narrow waters, rivers, canals, docks, etc., where an installation of the longitudinal type might seriously interfere with navigation.

Although, generally speaking, there are in existence comparatively few broadside slipways of big capacity, the system having been in the past confined mainly to the handling of river craft, etc., of comparatively small tonnage, there is, from a mechanical point of view, no difficulty in the way of greater expansion. It is, indeed, a fact that railway dry docks of the broadside type of from 2,000-10,000 capacity have been installed on the Crandall system at San Francisco and other ports in the U.S.A.

The great disadvantage of the broadside slipway is the amount of foreshore frontage which it occupies, particularly in this country where land is valuable.

Haulage Equipment

The question of haulage presents no difficult problems where various systems of wire rope haulage are available and it is safe to say that loads up to 5,000 tons can be efficiently dealt with by direct pull from a gear of the double drum type, operating on the two-part wire rope principle.

In a gear of this type, a good example of which is shown in Fig. 5, the wire rope passes round a balance pulley attached to the drawbar of the cradle, the ends being wound on two grooved drums, right and left helical. By this means, the pull is central and equalised and, if driven by two electric motors or other power units, the failure of one or other of these units does not render the slipway inoperative for full load, the arrangement of gearing being such that either unit can drive either drum, thus providing in such an emergency, a double purchase system whereby the maximum load can be handled at half the normal hauling speed.

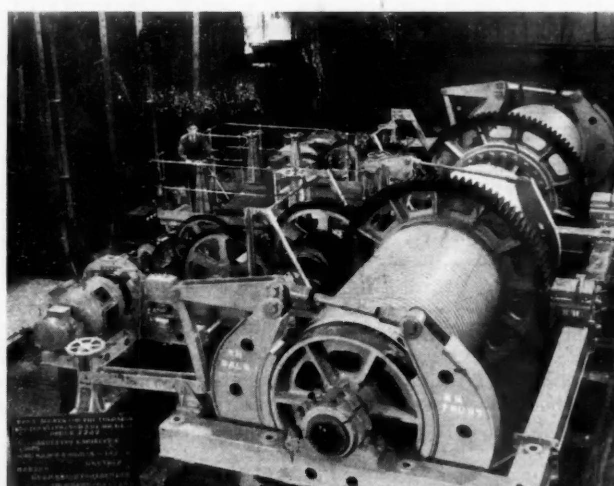


Fig. 5.

A more economical type of gear to construct for heavy loads is that of double purchase where the wire rope is anchored at one end, the bight passing round a double purchase pulley attached to the drawbar of the cradle and the free end brought up and wound on a helically grooved drum. While this type is not so

Marine Slipways—*continued*

flexible as that of double drum, being driven by one power unit only through a single train of gearing and with the added disadvantage of a very long drum together with a slight tendency to pull to one side, some very heavy and successful equipments are in operation, notably one of 4,000 tons capacity at Hong Kong. It is considered that the limit of a gear of this type may be put at approximately 5,000 tons.

Where the requirements are in excess of the above weight, the haulage can still be done on the wire rope principle by utilising the double drum type of gear, but with each drum working in the double purchase principle, producing a four-part wire rope haulage system. Very high actual breaking strains of wire ropes are obtained if the flattened strand form of construction be adopted. Thus, to handle a ship of approximately 10,000 tons on a cradle working on an incline of, say, 1 in 20 and basing calculation for the wire rope on a factor of safety of 4 the actual B.S. of the wire rope required should not exceed 880-900 tons to provide which a rope of $13\frac{3}{4}$-in. to 14-in. in circumference and of flattened strand construction would be necessary.

Wire ropes of $13\frac{1}{2}$-in. cir. with B.S. of 760/800 tons are at present in use on slipways in the Far East and working with every satisfaction.

It is estimated that to deal with a vessel of 10,000 tons on an incline of 1 in 20 at a speed of 10-ft. per minute, approximately 1,000 h.p. would be required.

Although the double drum two-part wire rope haulage system is generally recommended for slipways in excess of, say, 6-800 tons capacity, there are cases where such an equipment is hardly warranted and gears of the single wire rope haulage system are more commonly adopted. This is a direct pull from the drum by a single wire rope. It is simple in the extreme and equipments up to 1,600 tons are known to be working satisfactorily on this system.

It is considered advisable that an efficient system of downhaul be provided for most slipways, even in cases where the incline is steep and the light cradle will descend under gravity but, perhaps due to silt or other obstruction, not to the full extremity which must be reached if sufficient draught of water is to be obtained over the forward keel block. It is here that an efficient downhaul gear is invaluable.

Generally the downhaul wire rope is anchored to an attachment well forward on the cradle, is led down the incline and round a return pulley positioned at or near the lower extremity of the of the track and thence led up and wound on the downhaul drum. This may either be driven through gearing or, preferably mounted on extensions or extension of the main drum shafts or shaft, free running and controlled by friction clutch or dog clutch. In this case, the diametric centres of the main wire rope coiled on its drums or drum must be co-equal with that of the downhaul wire rope coiled on the downhaul drum. This ensures that the downhaul drum will take in or pay out its rope at precisely the same speed as that of the main drums. This is considered to be an important point in design.

Fig. 5 shows the downhaul drum mounted centrally between the two main drums, the former being controlled by friction clutch.

What then is the limit to the capacity and efficiency of a slipway built on British principles? Surely not 5,000 tons, but in the neighbourhood of 10,000 tons.

The Transportation of Fruit for Export

An Important South African Industry

More than 6,000 miles separate the fruit trees of South Africa from the export markets in Europe. It may be three weeks or more after picking before the fruit is eaten. With a delicate and perishable product like fruit, it follows that the whole export structure is ruled by these two factors of time and distance. They can only be conquered by scientific transportation capable of prolonging the life of the fruit and preserving its quality. This is now a commonplace achievement. To-day, when a bunch of South African grapes reaches the consumer's table in London or Stockholm, the fruit as as wholesome and tasty as if it had just been picked in a Paarl vineyard.

South Africa's first fruit orchard was planted at the Cape 294 years ago to help provision the ships of the Dutch East India Company plying between Holland and the Far East. The first ship van Riebeeck provisioned from this orchard started an export trade which has since seen the shipment of nearly 10,000,000 cases of fruit in a single year.

As recently as 35 years ago, however, the fruit export industry was still in its infancy. Before the first world war the Union's shipments of deciduous fruit amounted to little more than 1,000 tons a year, and citrus exports were equally negligible. Since then a phenomenal change has taken place, and in 1939 the country exported no less than 357,000 tons.

One single influence, far more than any other, accounted for the transformation, and that was the development of refrigeration and the erection of pre-cooling stores at the principal ports. The pre-cooling stores built by the South African Railways and the introduction of refrigerated and ventilated fruit trucks have enabled the farmers of the Union to establish an industry which is now second to the wool industry in its value to the country.

The relationship between the expansion of the pre-cooling services at the ports and the growth of the fruit export trade is best demonstrated by the developments which have taken place at Cape Town, where most of the fruit is shipped, since the first world war. The growth of the Union's fruit exports began with the opening of the first cool chambers in 1915. The impetus this gave to the export of fruit was obscured while the war was in progress, but from 1919 to 1925 the annual exports climbed rapidly from 3,783 tons to 45,380 tons, an increase of more than 40,000 tons in six years. In 1925, the Railways opened a new and much bigger system of cool chambers on the East Pier, and in the next ten years the exports rose from 74,229 tons to 205,396 tons a year. A new store was completed in 1936, and in 1939, the growers shipped 357,000 tons, an increase of about 150,000 tons in three years.

To-day, Cape Town's pre-cooling stores, which cost £414,000 to build, are the largest in the world, and the method of handling the fruit is the best which contemporary science can devise, as shown by the superior quality of the fruit at the end of its long journey. More than 65,000 packages of fruit, measuring 1,400 shipping tons, have been received and stored in a single day. At the height of the season, the stores have held more than £80,000 worth of fruit. The fruit is usually shipped as fast as it is received, subject only to the time required for pre-cooling, and as many as four ships can be loaded simultaneously. An underground corridor and an overhead gantry link the main store on B Berth with two other berths so that ships do not have to wait their turn when time is an important factor.

The principal pre-cooling store at the Duncan Dock is a vast shed 875-ft. long and 60-ft. wide with 25 cooling chambers capable of storing 7,000 tons of fruit. The cooling chambers occupy the centre of the shed, extending from one end to the other like a row of great ice boxes. They are flanked on one side by the unloading platform, where the fruit trains pull in, and on the other by the shipping corridor, where the fruit eventually emerges alongside the wharf to be lowered into the waiting ships.

In the whole of this process, the fruit is handled only twice—once in the unloading of the trucks and a second time when it is packed into the ship's hold. Since fruit deteriorates every time it is handled, this has been a guiding principle in the design and operation of the pre-cooling stores. The elimination of handling is based on the use of flat trolleys, known as skids, each capable of carrying about 4 tons of fruit. When the trucks are unloaded, the boxes of fruit are packed on to these skids, and until they are removed in the ship's hold the fruit remains untouched. This method was evolved in South Africa and is without parallel anywhere in the world.

Notes of the Month

Rehabilitation of the Port of Amsterdam.

The Amsterdam Corporation has placed orders with Scottish firms for 20 small electric cranes at a cost of 2½ million guilders. The Corporation has also applied for a credit of 1,625,000 guilders for the more urgent harbour repairs to be carried out. These include repairs to quay walls blown up by the Germans and to warehouses and stores.

Saigon to be an Autonomous Port.

A report from Batavia states that it has been decided to establish Saigon as an autonomous port controlled by a body of nine members representing Cochin-China, Cambodia, Laos and French interests. Foreign trade will be supervised by the Federal Government, and a Customs union will be formed by the Federal States. The sole currency in the port will be the piastre.

Annual Meeting of Scarborough Harbour Commissioners.

At the annual meeting of the Scarborough Harbour Commissioners held recently, the Chairman, Mr. D. B. Atkinson, reported that although the profits for last year amounting to £4,062, are considerably more than in normal years, the Commissioners have not the assets to cover the cost of maintenance work, which included dredging and repiling the harbour, rectifying the subsidence of the West Pier, and other improvements required to bring the piers up-to-date.

Port of Bremen in Working Order.

The Port of Bremen is again in working order, and cargoes which for some time had to be discharged at Bremerhaven, at the mouth of the river, are once again being unloaded at Bremen. The port is being used for the transport of U.N.R.A.A. supplies to the United States zone of occupation, and cargoes unloaded during the 12 months ended June 30th, 1946, included over 800,000 tons of oil.

Another Continental Link Restored.

The Harwich-Zeebrugge train ferry service of the London and North Eastern Railway, which ceased at the outbreak of the war, was resumed on 16th August last, when the "Essex Ferry," known before the war as "Train Ferry No. 1," sailed from Harwich for Zeebrugge. For the return trip, the "Essex Ferry" carried a number of Italian railway wagons loaded with fruit for the London market. For the time being there will be three sailing each way weekly.

Salvage Work in France.

The River Loire will be diverted over a distance of two miles to enable salvage to be undertaken of the whale oil refinery *Antarktis*, sunk below Nantes during the German occupation. Work is scheduled to begin this month. Two large dredgers, the *Pas de Calais* and *Fatouville*, are also embedded in the mud between the villages of Coueron and Pellerin, where the river forms a bend. They will be salved because of their exceptional value. A concrete barrage will be erected to divert the river into an artificial bed.

Brazilian Harbour Improvements.

A $10 million programme for the modernisation of the Port of Rio de Janeiro, which has been prepared by the Brazilian Ministry of Transport and Public Works, allows for a considerable enlargement of docking and warehouse space, construction of piers at Ponte de Caju, and the possible addition of a second tier to the present warehouse units or the building of new units. More than $5 million have been appropriated for the purchase of cranes, locomotives, cars, electric overhead cranes, mechanical stackers and floating cranes. In addition, a Government decree has authorised the building of docks at an approximate cost of $1,250,000 at Pelotas in the State of Rio Grande do Sul, and plans for the improvement of Porto Alegre harbour facilities, involving the expenditure of about $167,500.

Harbour Facilities at Lysekil.

It is reported from Sweden that new harbour facilities have been made available at Lysekil on the west coast. Vessels up to 8,000 tons deadweight can now enter the port without difficulty.

Oder-Danube Canal.

A Polish report states that plans have been completed for the construction of a canal linking the Oder and the Danube, and thus the Black and Baltic Seas. Work on the canal is expected to begin shortly in both Poland and Czechoslovakia.

Floating Dry Dock Launched at Pittsburgh.

A floating dry dock with a lifting capacity of 6,000 tons, has recently been launched at Neville Island, Pittsburg, on the River Ohio, U.S.A. The dry dock, which is said to be the largest vessel to be launched on island rivers, is 448-ft. long and 97-ft. wide, and has a 73-ft. wide docking chamber.

Bombay Harbour Improvements.

A project to deepen and modernise the Prince's and Victoria Docks in Bombay Harbour, at a cost of nearly 30 million rupees, is contemplated by the Bombay Port Trust. The scheme, which is expected to take more than four years to complete, has been submitted to the United Kingdom for expert opinion.

Australian Port Officials' Tour.

The Vice-President of the Maritime Services Board (Mr. G. A. Whitton) and the Acting Engineer-in-Chief (Mr. C. R. Bickford) left recently for England and the United States where they are to investigate general port matters. It is expected that their tour will take at least five months.

Gothenburg Harbour Development.

A new stage in the development of Gothenburg Harbour has been decided upon by the Gothenburg Town Council, who have accepted in principle, a proposal by the Harbour Board to grant a sum of 5.7 million kronor for the provision of engineering equipment, shipyard and storage houses in the Tingstadsvassen district.

Reconditioning Equipment at the Pork of Landskrona.

The equipment of cranes at the Port of Landskrona are to be modernised and extended. About kr. 335,000 will be spent for the purchase of a new crane and the modernisation of three old units. The harbour is to be dredged. During the first six months of this year ports dues amounted to kr. 228,000 compared with kr 123,000 in the corresponding period of 1945.

Clyde Trust Revenue.

A decrease of nearly £159,000 in the revenue of the Clyde Navigation Trust was reported at the monthly meeting held in Glasgow on August 6th last. Total revenue amounted to £1,087,385, compared with £1,246,157 for the year ending June, 1945. There was a decrease of 198 in the number of large ships entering the harbour compared with the previous 12 months, and coastwise shipping also showed a big reduction in tonnage. The principal loss in revenue was in outward tonnage, due to the lack of heavy industry materials and coal for the export trade.

Hydrographic Survey of Greenland.

The Danish Government has placed an order with the Decca Navigation Co., Ltd., for a complete chain of navigator stations, together with receiving sets, for the purposes of hydrographic survey of Greenland The entire equipment is to be constructed in transportable form suitable for unloading on to the precipitous Greenland coast. From each location it will be possible to survey an area of between 50,000 and 75,000 square miles before moving the stations to the next location. The authorities estimate that by this means they will carry out a hundred years of survey work in less than 10 years. The value of the contract is understood to be about £30,000.

The Use and Validity of Models in Harbour and Estuary Investigation

By HERBERT CHATLEY, D.Sc. (Engrg.), M.Inst.C.E.

The practice of making working models to reproduce in miniature the conditions and behaviour of an estuary or harbour is steadily advancing and in most large hydraulic projects it is now generally recommended as a preliminary step. Provided it is reliable, the advantage and economy of the practice are very obvious.

It is therefore worth while to go somewhat into the principles that dominate the working of such models and to consider what models can show and how far their indications may be relied upon.

The sorts of question which a hydraulic model is required to answer are as follows:—

(1) **Tidal Changes.**

In a tidal area (into which a river may enter) what changes in currents, tides and bed form will be consequent upon the lapse of time or will happen if certain artificial changes, e.g., dredging, training works, barrages, jetties, bridge piers, reclamations, harbour basins, etc., are introduced.

(2) **Accretion and Erosion.**

What are the conditions which determine the form of a mobile sea bed and how may they be modified to reduce or increase siltation or to prevent or increase erosion.

(3) **Wave Action.**

How will wave propagation and intensity be altered in a prescribed area by the construction of groynes, wave-traps, tidal basins, spending beaches, etc.

The theory of "dynamical similarity" which controls the relation of a hydraulic model to the actual objects it represents was first demonstrated by Froude in 1876 for ship models in tanks and by Osborne Reynolds in 1885 for estuaries. It was later developed by Rayleigh and others with special relation to aircraft in wind tunnels. It is probable that to the very great success achieved with ship and aircraft models in tanks and tunnels may be attributed the greater confidence which is now felt in estuary models.

The essential feature of "dynamical similarity" is that the various forces acting on corresponding masses of fluid shall be in the same ratio in the model as in the prototype. Thus in a channel there should be the same ratio between the friction on the bed of the channel and the gravitational drive of the whole mass of water in the channel in the model as exists in the prototype.

In the case of ships, aircraft, sluices and certain small highly localised estuary problems, the models are in natural proportions, i.e., the vertical and horizontal dimensions are in true ratio and the slopes are therefore as in the prototype, but for most estuary, river and harbour models it is inevitable that the vertical scale shall be coarser than the horizontal scale. Rather paradoxically in many cases this produces better similarity of behaviour than would occur with true proportion owing to the laws of hydraulic friction, but there is a definite limit to this effect.

The size of a model is necessarily restricted by economical and practical considerations and this automatically controls the horizontal scale. If this same scale is used for vertical dimensions the rise and fall of the water in the model and the "heads" become so small that they cannot be satisfactorily measured and the currents produced by such minute heads will be so weak that the flow and frictional conditions will be largely or even wholly what is termed laminar, sub-turbulent, irrotational, viscous, streamline or glassy, whereas in the prototype the flow is almost certainly to a great extent turbulent, eddying, rotational or vortical. "Irrotational" flow is a pure shear effect and the kinetic energy of the water remains translational, but "rotational" flow means that part of the water spins like a solid and all such kinetic energy of spin is quite irrecoverable except as heat.

As an example, if a model is required to represent an area of say 30,000-ft. by 12,000-ft., and it is not practical to make the model larger than say 20-ft. long, the horizontal scale is limited to 1 in 1500 or smaller. If now the actual tidal rise and fall is 10-ft., at this same scale the rise and fall would be only 0.08 inch and the tidal currents would be infinitesimal. In fact, with usual tidal ranges, unless the vertical scale is of the order of 1 in 100 (which makes a 10-ft. tide = 0.1-ft. or 1.2-in. in the model), it is not practicable to measure the tides, and, what is even more important, the stream velocity will not be turbulent and frictional conditions will be "laminar" and so utterly different from those in the estuary.

Reynolds proved that the criterion of transition from "laminar" to "turbulence" is that what is now termed the "Reynolds number" shall exceed a value of about 1,400, or possibly as high as 3,600.

The Reynolds number for water at 15°C is 100 v_1 d_1 and increases slightly with temperature, in centimetre-gram-seconds units where v_1 is the stream velocity (cm/sec) and d_1 is the depth of the channel (in centimetres)—

v in ft. per sec. = v_1 /30.48
d in ft. = d_1 /30.48 so that if v_1 d_1 has to exceed say 36 then

$$v\ d\ (\text{foot units})\ \text{must exceed}\ \frac{36}{929}\ \text{say}\ 0.04$$

Thus if the channel in the model is 0.4-ft. deep the velocity should be more than 0.04/0.4 = 0.1-ft. per second for the flow to be turbulent. If the gravity induced flow in the model produced by the tide generator (a mechanically operated oscillating plunger or flap) is similar to that in the prototype due to the oceanic tide, the velocity in the model will be proportioned to that in the estuary as the square root of the vertical scale ratio, and if this is 1 in 100 the velocities in the model will be reduced in the ratio of one-tenth and a velocity of say 2-ft. per second in the prototype due to a tidal range of say 10-ft., will become in the model 0.2-ft./second with tides of 1.2 inches range. In this particular case the Reynolds criterion is probably satisfied, but this vertical scale is quite impracticable to use for the horizontal dimensions, except in a model which only represents an extremely limited area. Thus, in this case, a stretch of one sea mile would be 60-ft. long, which would generally be quite unacceptable.

Reynolds, from his experiments, deduced an empirical relation for the "distortion" which appeared necessary with a given vertical scale to ensure that the velocity in the model should be turbulent:—

$$e\ \text{should equal or exceed}\ \frac{0.09}{h^3}\sqrt{\frac{30}{H}}$$

where h is the maximum tidal range in the model, measured in feet, e is the exaggeration of slopes in the model due to the use of unequal vertical and horizontal scales. H is the maximum tidal range in the prototype also measured in feet, which was 30-ft. in the Mersey.

[Gibson considers that the co-efficient 0.09 was much larger than necessary; in actual fact the value of this formula is questionable and it should only be considered a guide].

*The velocity of tidal currents in an estuary is of the order of

$$\frac{\sqrt{g}\,.\,h}{2\sqrt{d}}\quad\text{or}\quad\frac{\sqrt{gd}\,.}{2}\,.\sqrt{\frac{h}{d}}$$

$$\text{or}\quad\frac{\sqrt{gd}}{2}\,.\,\frac{h}{d}=\sqrt{gd}\,.\,\frac{h_2}{d}$$

when h is the range and d is the still water depth, *e.g.*, h = 8 ft. and d = 32 ft., v = 6 ft. per sec. or 3.6 knots.

Use and Validity of Models in Harbour and Estuary Investigation—continued

Thus if H is 10 and h = 0.1 (vertical scale of 1 in 100) e might be

$$\frac{0.09\sqrt{3}}{0.001} = 156!$$

which would make the horizontal scale 1 in 15,600 or nearly 5-in. to the sea mile. If H = 20 and h = 0.2, e is indicated as 16.

[There are various good arguments for limiting e to a value equal to the square root of the vertical scale factor, i.e., in this case, $\sqrt{100}=10$].

It will be observed that according to Reynolds' formula the larger the tidal range in the model the smaller is the indicated exaggeration of slope.

With a high degree of distortion of scale small tidal ranges in a model will suffice to produce the indispensable turbulence, but this advantage is offset by several serious defects. On the other hand, in loose beds, Lacey, by comparison of rivers, has shown that similarity of behaviour is strongest when the distortion is the square root of the vertical scale factor, or, what is the same thing, the cube root of the horizontal scale factor.

The exaggeration of scale leads to many complications, of which the following are the most important:—

(1) In an alluvial bottom the cross slopes in the model may exceed the angle of repose of the material, so that if the bed is not to slip the slopes must be stiffened with a cohesive admixture, and this will not correctly represent the natural condition of limited stability in the prototype.

(2) If the distortion exceeds $\sqrt{m}$ where the vertical scale is 1/m the trajectories of settling particles may be flatter than those which occur in the prototype in corresponding times so that coarser silt must be used or the silt settlement must be accelerated by coagulants.

(3) The transverse sections of water channels have perimeters and hydraulic radii which do not truly correspond to those of the prototype and this shape effect affects the flow conditions and the frictional coefficients.

(4) The gross friction to gravity ratio is not preserved except for certain values of the distortion; the value $e = \sqrt{m}$ appears to be the most favourable.

(5) The scouring effects vary with the distortion in a complex and unpredictable manner.

There are other difficulties with models, of which the most important are:—

(1) **The physical boundaries of the water area** of the model which correspond to open water in prototype. These should be such that they lie along a line of flow and so do not cause reflection or transverse disturbance. As the currents may change in direction this is often a matter of compromise. Frictional effects at such boundaries must also be watched and if necessary allowed for.

(2) **The Reynolds number** in the model is necessarily low, but is very large in the estuary. With increasing Reynolds numbers the coefficients of friction diminish possibly as the fourth root of the Reynolds number, to perhaps one-fifth. This is advantageous in some respects but not in others. Gibson holds that this diminution is only true for simple and smooth channels and that with the irregularity and tortuosity of natural channels the "friction" is largely pure eddy generation by curvature, constriction, expansion, splitting and deviation, for which the gross coefficients of resistance are independent of the Reynolds number when it is above low critical value. (If so there is dissimilarity of the force ratios when there is distortion of scale).

(3) **The granular behaviour of the bed material.** It is clear that if the grains of the bed are reduced in the ratio of the vertical scale, even if the stuff in the prototype is rather coarse, that in the model may be impalpably fine, or vice versa the finest material in the model might correspond in the vertical scale to pebbles in the prototype. Alternatively, if the same material is used in both, the relative roughness (grain diameter divided by channel depth) may be very much higher in the model. Also there may be difficulty with cohesion if very fine material is used in a model. In actual fact it is found paradoxically that very analogous results are often obtained by using much the same material in the model as exists in the prototype, although a small reduction may be expedient. This is related to the very complex question of the flow of the water near the bed. At a certain very small distance above the bed the velocity of the water is very little dependent on the depth of the water, but very dependent on the coarseness of the material, so that at this level the friction up to the inception of scour is almost independent of scale. This is a very complex problem, which can only be resolved by experiment.

(4) **The approach of the artificial tidal wave** must be adjusted, if necessary, by guiding baffles, so that within the area to be examined the correct tidal heights are produced at all relevant points. The tide generator itself also needs to be adjusted very carefully to ensure that such true tides occur in the model and it may be necessary to shape the plunger or flap specially in order to make the shape of the tide wave correct.

Having regard to all these problems the actual operation of an estuary model consists first in its empirical adjustment to reproduce reasonably well the physical conditions of tide and current in the prototype.

The siltation and erosion are next considered and adjustments made to the bed materials and the acidity or alkalinity of the water until there is again reasonable conformity to prototype behaviour. Only after these things have been done can one adventure upon the difficult realm of prophecy as to the effects of time or artificial change.

In the case of wave action, as the length of the wave is as important as its height it is desirable if possible that natural proportions shall be preserved and the waves should be appreciably larger than the "capillary" ripples which are dominated by surface tension. For this reason it is usually impossible satisfactorily to incorporate wave action in a distorted estuary model. It is necessary that the wave length should bear the same ratio to the width of openings as occurs in nature for the "diffraction" of the waves to be adequately represented. There is one case in which capillary waves can throw light on wave propagation in basins. If a shallow "ripple" tank is designed to represent the layout of an estuary, harbour basin or the like and waves are generated by an oscillating long float extending right across the open sea breadth of the model (in the right direction) and illuminated "stroboscopically" so that the motions can be seen visually (or be photographed) in spite of the high speed of the capillary waves the manner in which openings or obstructions reflect, diffract or partially admit the waves can be well demonstrated. This can also be done with gravity waves, but the energy in such waves is large and they must be intermittent or be absorbed at the beaches without appreciable reflection if they are not to react upon the wave generator with very confusing results.

Scale Relations of Models.

Horizontal scale $\frac{1}{L} = \frac{1}{n} = \frac{1}{em}$

Vertical scale $\frac{h}{H} = \frac{1}{m} = \frac{e}{n}$

Distortion $= \frac{n}{m} = e$

Velocity scale $= \frac{1}{\sqrt{m}}$

Necessary velocity of silt settlement scale $= \frac{e}{\sqrt{m}}$
(for identical grains)

Time of tidal cycle scale $= \frac{1}{e\sqrt{m}}$

Discharge scale $\frac{1}{e\,m^{2\cdot5}}$

Volume discharged in cycle scale $\frac{1}{e^2 m^3}$

Three Spanish Breakwaters

Diverse Solutions of the Same Problem*

By FRANCISCO AYUSO AYUSO
(Director of the Castellon Harbours of Valencia, Spain).

During the construction of the protective works for the Castellon harbours (on the East Coast of Spain) which I had the honour of supervising, and particularly those of Vinaroz, Benicarlo and Burriano, there had to be faced the problem, sufficiently common at Mediterranean ports of the inadequacy of the adopted typical section to resist the waves actually encountered, and since the

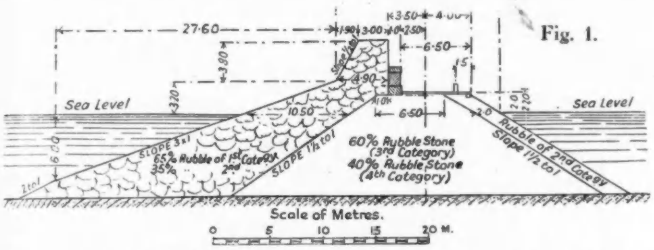


Fig. 1.

diversity of conditions presented at each of the harbours did not admit of, nor favour the employment of the same design for all, it became necessary to contrive three distinct solutions for the same problem, as stated below.

The Harbour of Vinaroz

In fig. 1 is shown a typical section of the eastern breakwater, which is directly exposed to storm waves. As can be seen the external covering of rubble with a slope of 2:1 between—6.00 m. and the bottom; of 3:1 between—6.00 and + 3.20, and of $\frac{1}{2}$:1 between + 3.20 and + 7.00, the crest level, is constituted by 65 per cent. of rubble of the first category, i.e., pieces of weight exceeding 4,000 kg. and by 35 per cent of rubble of the second category, i.e., pieces of weight between 1,000 and 4,000 kg.

From a study of the wave charts, it was found that waves of 5.40 metres in height might attack the breakwater. The density of the rubble stone was 2.685.

With these data and for a slope of 3:1 $(\cos\alpha - \sin\alpha)^3 = 0.254$, from Professor Iribarren's formula, we have

$$P = \frac{15 \times A^3 \times d}{(\cos\alpha - \sin\alpha)^3 \times (d-1)^3} = \frac{15 \times 5.40^3 \times 2.685}{0.254 \times 1.685^3} = 5{,}350 \text{ kg.},$$

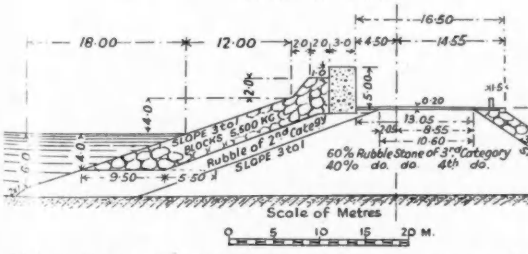


Fig. 2.

which indicates that the section in fig. 1 is not a sufficiently stable type since the covering layer would have to be composed of blocks heavier than 5,350 kg.; actually, for this conglomeration of rubble of first and second categories, there are in the covering layer blocks of little more than 1,000 kg. in weight. Accordingly the autumnal storms of 1942, which were extremely violent, although certainly the height of the waves did not exceed the 5.40 metres deduced from the wave charts, completely levelled the constructed portion, disintegrating it practically to a shapeless and irregular mass at sea level.

In these circumstances, since the work was half completed, with a good quarry available as also a railway for the transport of material under reasonably good conditions, the contractor had serviceable means for utilising quarry refuse as a nucleus for the portion of the work not yet executed, as also for certain filling of the harbour beach included in a separate scheme.

All this permitted the substitution of a new section design (fig. 2) which was approved by the authorities, possessing an outer cover of 3:1 between—6.00 b and + 4.00 m of 2:1 between —6.00 m. and the bottom, and of 1:1 between +4.00 m. and + 6.00 m., this being constituted of blocks in excess of 5,500 kg. between—4.00 m. and + 6.00 m. and with second category rubble (pieces between 1,000 and 4,000 kg.) from —4.00 m. down to foundation level; also the intermediate cover between the 5,500 kg. blocks and the nucleus was of rubble of the secondary category. The thickness of the outer layer, 9.50 m. is composed of three blocks. The section was further improved by a concrete parapet, 5 m. in height and 3 m. thick at the level of + 7.00 m. The increase in width of platform, which by superior direction was reduced to 13.50 m. over all, was due to other reasons which are expounded here.

The level of the parapet crest, + 7 m., is in accordance with the advice of Professor Iribarren who fixed it at

$$\frac{5}{4} \times A = \frac{5}{4} \times 5.40 = 6.75 \text{ m.}$$

The level for the summit of the breakwater mound + 4 m. also agrees with the formula $\frac{3}{4}$ A = 4.05 m.

From the depth of 4 m. as far as the bottom, there has been substituted for the covering of blocks exceeding 5,500 kg. rubble of the second category. This is perfectly admissible, according to deduction from the following.

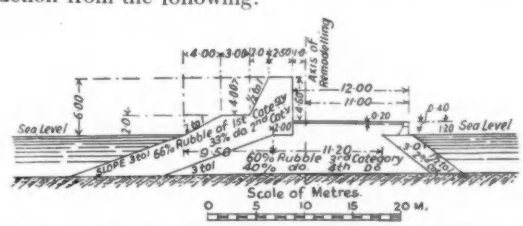


Fig. 3.—Sectional Profile of Eastern Breakwater without reinforcement at the Port of Benicarlo

From the height of the wave A=5.40 m., it has been deduced that L_o = 60 m. Then:

$$\frac{H}{L_o} = \frac{4.00}{60.00} = 0.066.$$

Inserting this value in column 4 of a previous article (January 1st, 1941) in the Revista de Obras Publicas there is derived from column 5, K =2.283 and in column 3, $\frac{L}{L_o} = 0.438$. Therefore:

$$L = 0.438 \times L_o = 0.438 \times 60 = 26.28\text{m.}$$

and it can be inferred that

$$\frac{\pi H}{L} = 0.479 > \sin h \frac{\pi H}{L} = 0.50$$

$$r = \frac{h}{\sin h \frac{\pi H}{4}} = 5.40 \text{ m};$$

$$A^1 = \frac{2\pi r^2}{LK} = 3.03 \text{ m}$$

and $$P^1 = \frac{15 A'^3 d}{(\cos\alpha - \sin\alpha)^3 \times (d-1)^3} = 945 \text{ kg.}$$

that is to say that, below a depth of 4 m., blocks of 1,000 kg. weight can be employed and so those of the second category suffice.

At a depth of 6 m., the slope is altered, continuing at 2:1. If the calculation is repeated it will similarly be found that pieces of the second category are sufficient.

These values are reliable, seeing that as can readily be understood, the maximum molecular velocity $V = \frac{\pi r}{T}$ is lower than that of the revolving wave $V = \sqrt{gh}$.

To this sectional profile there have already been constructed,

*Translated from the Spanish article in "Revista de Obras Publicas," February, 1946.

Three Spanish Breakwaters—continued

by contract with the Sociedad Iberica de Construcciones y Obras Publicas S.A., some 300 lin. metres of breakwater, which has resisted the autumnal storms of 1945 without the disturbance of a single block.

Harbour of Benicarlo

Fig. 3 illustrates the profile type corresponding to the arrangement adopted for the entire construction of the Eastern breakwater, which is likewise the recipient of wave ouslaughts. As can be seen, the outer covering has a slope of 3:1 only for the submerged portion and continues at 2:1 between zero and + 2.00 m., at which level there is a horizontal berm of 3 metres followed by a slope of $\frac{1}{2}$:1 up to the level of + 6.00 m. (crest height), being formed as regards two-thirds of its bulk by rubble of the first category (blocks in excess of 3,000 kg.) and as regards one-third, of rubble of the second category (blocks between 1,000 and 3,000 kg.).

The maximum wave height anticipated against the breakwater as deduced from the wave charts is 5.60 m. For that, with a density of 2.7, which is that of the stone, and with the slope of 3:1 (in the submerged portion, though outside that it is steeper) Iribarren's formula gives us the minimum weight of the blocks as 5,750 kg. This demonstrates that the design is not suitable, seeing that where there ought to be blocks in excess of 5,750 kg., with the slope of 3:1 which is prolonged to the level $\frac{3}{4}$ A=4.20 m., there are blocks of only 1,000 kg. with a 3:1 slope for the submerged portion and steeper beyond. Accordingly it happened that the autumnal storms of 1942 opened out in the crest, a gap of more than 50 metres and brought about a complete dislocation of the remainder.

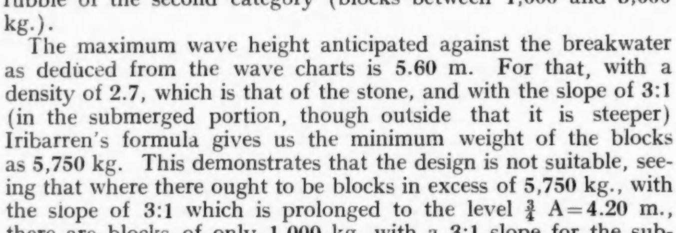


Fig. 4.—Strengthened Sectional Profile of Eastern Breakwater at the Port of Benicarlo

In considering the modification to be introduced into the section, it was thought at first to make use of a disposition similar to that at Vinaroz which was abandoned only because the contractor had not the auxiliary track to transport the material from the quarry, 8 km. distant this having been destroyed during the civil war; furthermore, even if the rail track had been available this solution would have been inadmissible since it involved the supply of some 80,000 tons of blocks exceeding 5,500 kg. without possible use for the residue from the quarry, reckoning that it would be necessary to produce and remove from the quarry, without possible use, some 250,000 tons of stone, which would have greatly increased the cost of the tonnage actually used.

In view of this and with the concurrence of Professor Iribarren, it was proposed and sanctioned by the authorities that the section should be as shown in fig. 4, consisting in the demolition of the crest down to sea level, turning the rubble on to the slope by which it was modified to 4.18:1, retaining the larger blocks of 5,500 kg. to form a defensive work of triangular section with a slope of 3:1 and replacing the crest by two large concrete blocks; the outer one, 4 metres in breadth founded at + 0.50 m. above sea level and comprising 2 steps of 2 m. each, and the inner one, 6 metres in breadth with 3 steps, finishing at the level of + 7.00 m. This has been achieved by reducing the width of the platform from 12 to 7 metres without any inconvenience. Connected with the high block in the platform is arranged a vent for air compressed by waves. Longitudinally, the blocks are 6 metres with staggered joints.

As can be seen, the result is a theoretical slope of 3:1 in the superstructure and of 4.18:1 in the submerged portion.

It has already been shown that blocks heavier than 5,500 kg. in the superstructure are stable. Below the water line, with a slope of 4.18:1, Iribarren's formula gives a minimum weight of 3,560 kg., which agrees with blocks of the first category, which are located there. At 4 metres depth, the minimum theoretical weight is 770 kg. per block, for which the dismantled blocks of the second category suffice.

The work, perfectly executed by the contractor, D. Francisco Panadero Coello, has excellently withstood the autumnal storms of 1945 without the least damage.

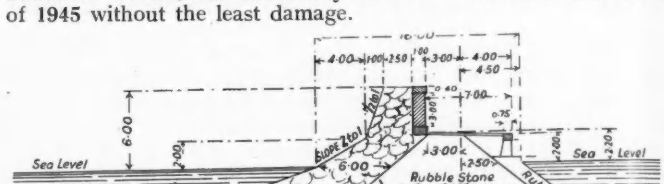


Fig. 5.—Sectional Profile of Eastern Breakwater, Port of Burriana

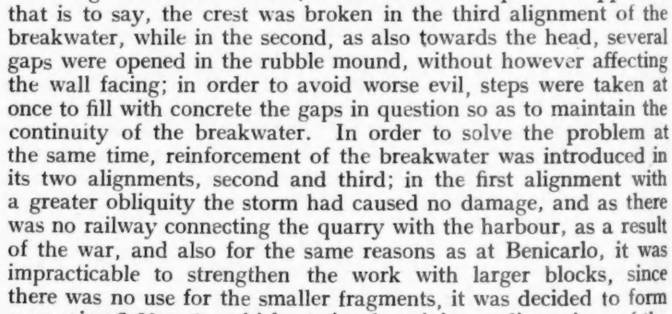
Harbour of Burriana

Fig. 5 shows the profile type adopted in the case of the Eastern breakwater which likewise is exposed to direct wave attack. There, too, there is a mixture of rubble in the covering layer in the proportion of two-thirds first category (blocks heavier than 4,000 kg.) and one-third second category (blocks of between 1,000 kg. and 4,000 kg.) while the slope which is 3:1 in the submerged portion is only 2:1 between the levels of zero and + 2.00 m and $\frac{1}{2}$:1 between + 2.00 m. and + 6.00 m.

Wave height as deduced from the wave charts is 5.90 metres.

During the storms of 1942, what was to be expected happened, that is to say, the crest was broken in the third alignment of the breakwater, while in the second, as also towards the head, several gaps were opened in the rubble mound, without however affecting the wall facing; in order to avoid worse evil, steps were taken at once to fill with concrete the gaps in question so as to maintain the continuity of the breakwater. In order to solve the problem at the same time, reinforcement of the breakwater was introduced in its two alignments, second and third; in the first alignment with a greater obliquity the storm had caused no damage, and as there was no railway connecting the quarry with the harbour, as a result of the war, and also for the same reasons as at Benicarlo, it was impracticable to strengthen the work with larger blocks, since there was no use for the smaller fragments, it was decided to form a covering 3.60 metres thick—twice the minimum dimensions of the stone blocks—with blocks of concrete masonry of 2.50 m. by 2.00

Fig. 6.



m. by 1.80 m. which, with a density of 2.2, gave a weight of 19.8 metric tons and with a slope of 3:1 were characteristics in accordance with the result of the application of Iribarren's formula

$$P = \frac{19 \times 5.90^3 \times 2.2}{(\cos\alpha - \sin\alpha)^3 \times (2.2 - 1)^3} = 19,693 \text{ kg}$$

In the upper portion, the cover was raised to + 4.50 m ($\frac{3}{4}$ A = 4.42 m.) and the crest, or parapet increased with concrete to the level + 7.35 m. ($\frac{5}{4}$ A = 7.38 m.).

With this section the work has already been reinforced for the whole of the third alignment and the pierhead and approximately half of the second alignment. It is expected that the remainder of the work will be finished during 1946; the completed portion has already proved a magnificent success.

Some Model Experiments Carried out in Connection with the Mulberry Harbour

*Review of Paper by F. H. Todd, B.Sc., Ph.D.**

Value in Peace-Time

Whilst the main purpose of Dr. Todd's experiments at the National Physical Laboratory, Teddington, was for military and naval operations, some of the results have a direct bearing upon matters connected with peace-time harbour work. Briefly, the problems which his experiments cover affecting every-day harbour enterprises are: (a) the resistance to towing of concrete hulks, caissons or pontoons, in fine weather and rough weather; (b) the floating stability of the same; and (c) the behaviour of these units under controlled sinking. Prior to Dr. Todd's work

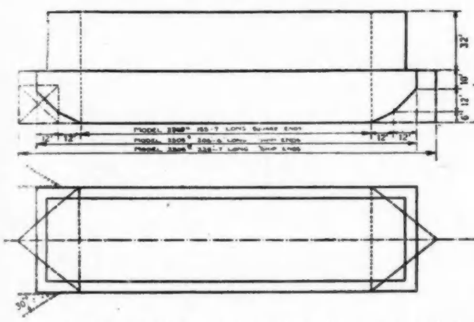


Fig. 1.

some of the results may have been predicted by experienced engineers or naval architects, but the confirmation by experiment was doubly valuable, as it enabled the naval personnel visibly to appreciate what their job entailed and gave a definite guide to the subsequent full-scale behaviour of the units. In other words, the experiments cleared away doubts and gave confidence to the operators that the job could be done, and to time.

Dr. Todd prefaces his paper with a brief reference to the usual general methods of constructing breakwaters; vertical walls; sloping beach and porous obstructions. The use of a floating breakwater was suggested and after consideration by the experimenters, they advised that it would be of little use unless it could be moored rigidly at rest as the waves approached it. However, to convince others less experienced, experiments were carried out, which showed how useless this type of breakwater would be.

Size of Models

The tank in which the tests were made was 20-ft. wide, so it was decided that the best proportion for the models would be 1/20th full size. The largest actual breakwater unit was 204-ft. long, 60 ft. high and 56-ft. beam with a draft of 30-ft. As is well known the Mulberry Harbour was to be only temporary (three months was estimated) and the sole purpose was to provide shelter for the landing of the necessities of war in quiet water. The landing stage at the end of a long floating pier (or roadway) had to be accessible and usable at all states of the tide and weather. Tests showed that without breakwater protection, even waves of moderate size, such as may normally occur in bad weather of summer months swamped the model landing stage.

It was therefore obvious that breakwater protection was necessary. The War Office and the committee of engineers, contractors and ship division of the National Physical Laboratory then decided upon the form and size of concrete hulks which were to be employed in the scheme. When the models of the breakwater were employed it was found that only a little spray topped the breakwater and the harbour water was quiet at the landing stage.

Towage Problems

Then there arose the problem of getting the units to the site, the seaworthy and navigational problem of towing. In the experiments to this end, Dr. Todd gives most interesting and important particulars. The displacement of the large units was no less than 9,000 tons. With such a massive, unwieldy structure of so low a breadth to length proportion, it is not surprising that it was decided to construct them with swim ends. This would conduce to make them more directionally stable, forcing the water under the bottom. Ship ends on the contrary would force the water sideways (see Fig. 1). The experimental tow wire was connected to a dynamometer and the length corresponded to 600-ft.

There were tests of the models in three forms, Fig. 1 (a) with swim ends, (b) with ship ends, (c) with square ends shown by the dotted lines. The results can be briefly summarised: (a), had least resistance but oscillated about the mean course about 5° at 6 knots, and 10° at 7 knots; (b) was directionally unstable swinging, out to out, over 400-ft., and had a resistance to towing about twice that of (a); (c) had a resistance about 2.75 times (a), but was directionally very stable. To prevent the high yawing of (a) two lee boards were fitted running fore and aft at the stern, as shown dotted. This reduced the oscillations but increased the resistance by 6% at 5 knots. With the lee boards fitted at 30° to the centre line of the hull yawing ceased, but the resistance increased to no less than 180% at 5 knots. Owing to constructional difficulties it was decided that the little relative advantage of lee boards was not worth while. As will be readily appreciated ship ends were out of the question.

A remarkable result of the tests was the marked high resistance in shallow water. It was found that with 7-ft. of water under the keel the resistance to towing was about twice that in deep water, between the speeds of 4 to 7 knots.

After the completion of the breakwater, additional units were required and it was decided to construct them with square ends. Since the tests had shown that the resistance to towing would be high, it was decided to experiment with temporarily fitted fairings at the extremities. These later units were then constructed as shown in Fig. 2. Alternative types of fairings were tried in other models; the fairings were of simple construction open at the ends. The intention was to cast them adrift as soon as the hulk arrived at the site for sinking. It was found that with fairings at both ends the resistance to towing was greater than with the fairings at the fore end only. With the fairing at the after end only the resistance was greater than without fairings at all. The fore end fairing reduced resistance of the square-ended unit about 50%.

The effect of speed of tow in rough water shows that the total resistance does not increase as rapidly as in smooth, for the same increase of speed; for example, for one type model the resistance in smooth water at 3, 4 and 5 knots was 13.1, 24.4 and 39.7 tons respectively. In rough water the resistance was 31.0, 41.5 and 57.0 tons, showing a percentage increase of 163, 73 and 40% respectively over smooth water, indicating that, within limits, an increase of speed in rough water means a reduction of the rate of increase of towing resistance.

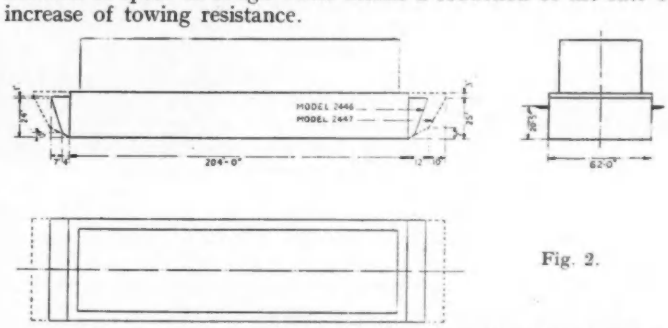


Fig. 2.

Resistance increases with height of wave and the additional resistance over that of smooth water is approximately proportional to the square of the height of the waves, of a given wave length. The greatest amplitude of the waves used in the test corresponded to 6-12-ft. With this height, however, it was found that the smaller concrete units would not survive with an open top—in spite of a freeboard of about 14-ft. The variation of resistance with the length of wave is interesting, as it shows that when the wave length is about equal to the length of hull, the resistance was a minimum, and the hull rode the waves easily, without breaking water. This is a most important point not only in the investigation of the stability and seaworthiness of floating bodies, but in a number of rigid maritime structures.

*Read at the Institution of Naval Architects, April, 1946.

Some Model Experiments carried out in connection with the Mulberry Harbour—*continued*

Sinkage

The experiments conducted to investigate behaviour during the sinking of the units are instructive as they emphasise the importance of a low centre of gravity and the necessity to divide up the free water surface. The units each had a central longitudinal watertight bulkhead and were divided into ten separate compartments by watertight transverse bulkheads. Each of these compartments had two valves for flooding, one 2-ft. and the other 12-ft. above the bottom.

One model unit conforming to the original design with a G.M. of 0.92-ft. initially floating in perfect equilibrium was flooded by opening all the valves. The model heeled over to 46° with the consequence that all the valves on one side were lifted out of the water and on the other yet further submerged; the water entering on the one side thus caused a further increase in the angle of heel. This behaviour was due to the low G.M. of 0.92-ft., and the large free surface effect of the water causing a loss of G.M. of 2.46-ft., reducing the initial positive G.M. to a negative one of—1.54-ft. This brought about an angle of loll of 20° to 23° and reduced the rate of influx of water on one side and increased it on the other. This, of course, could have been avoided by careful control of the flooding of selected compartments, but this, under the conditions, was inadmissible.

It was advised by the Ship Division of the National Physical Laboratory that the centre of gravity of the units should be lowered by adding thickness to the concrete bottom so as to attain a G.M. of 1.35 to 1.92-ft. with the inside bottom awash. Acting on this, experiments were made with units in which not only was the bottom slab thickened up, but dwarf longitudinal walls were added. The tests showed that a full-size unit with the bottom valves open would then sink, through a 6° tilt, in 37 minutes. With all the valves open the behaviour would be similar, but time of sinkage would be reduced to 19 minutes.

Further experiments with variations of positions of centres of gravity and dwarf walls were carried out. Eventually it was decided that the addition of 15½-in. of concrete and 18-in. high, longitudinal dwarf walls would answer the requirements of stability, providing the hull floated initially on a level keel.

Dr. Todd's paper further deals with the towing difficulties of the pier pontoons and the pier head.

Garston Docks

The Timber Port of the West Coast

Garston Docks are situated on the River Mersey, four miles south of the Liverpool Docks and on the same side of the river.

There are three inter-communicating docks known as the Old, North and Stalbridge, each having a separate entrance from the river.

There are 95 miles of sidings at the port, of which 8 miles are alongside the quays which are connected with the London, Midland and Scottish Railway main line.

The discharging and loading of vessels can proceed day or night, a complete electric lighting installation being in operation.

All services, viz., stevedorage, porterage, labour on the estate and in the warehouses, are undertaken by the railway company thus bringing the dock and rail services under one control, an obvious advantage to shipowners and merchants alike in regard to the expeditious handling of traffic at the port.

Vessels using Garston Docks are free of Liverpool Dock Tonnage Rates, but Harbour and Light Dues are payable to the Mersey Docks and Harbour Board. Pilotage is compulsory, the pilots being in the service of the Mersey Docks and Harbour Board. Liverpool tugs are always available.

Between 2,000,000 and 3,000,000 tons of imports and exports are dealt with annually.

Timber is specially catered for at Garston, and a heavy tonnage of all classes is imported. A total area of approximately 100 acres is provided for the storage of timber, and hydraulic and steam-travelling cranes are available for dealing with heavy timber on any part of the estate. Three large sheds are provided for the storage of " fine " woods requiring cover.

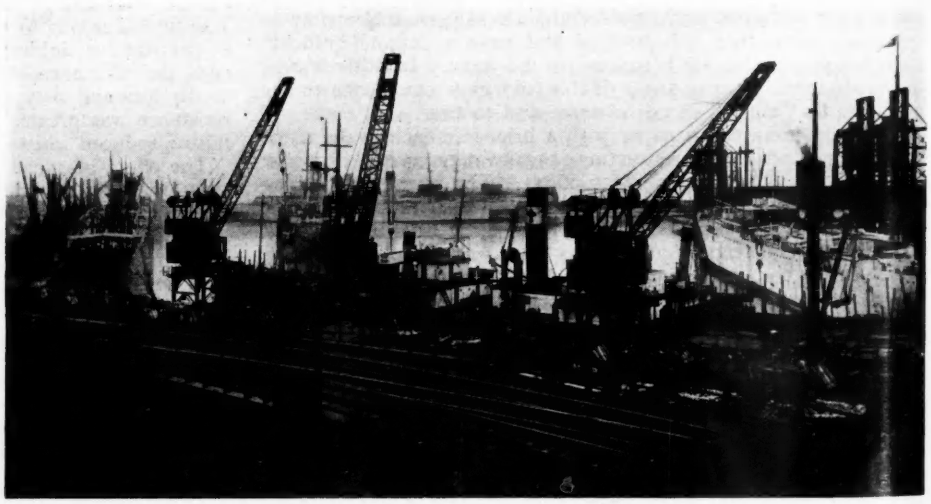
Coal.—Over 1,000,000 tons are exported annually, thus making Garston Docks the principal Coal Shipping Port on the North West Coast.

Minerals.—Electrical luffing grab cranes are provided for the rapid discharge of all kinds of minerals. There is also open storage on sleepered berths for upwards of 100,000 tons of minerals and similar traffics not requiring cover.

General Cargoes are catered for in all the docks, where ample cranage facilities exist, including electrically-operated 40-ton sheerlegs in the North Dock for dealing with heavy lifts.

The Docks

The most modern dock, Stalbridge, is approached by a dredged channel approximately 800-ft. long by 300-ft. wide, protected by a series of dolphins, and has an entrance lock 276-ft. long by which means suitable vessels can enter or leave the dock two or three hours before and after high water. The dock entrance is 65-ft. wide and berthing space within the dock extends to 3,170-ft.; vessels up to 500-ft. in length and 10,000 tons burden can be accommodated in the dock.



General View of Stalbridge Dock, Garston Docks.

The equipment comprises ample electrical and hydraulic travelling cranes up to 7 tons capacity.

Four 30-ton hydraulic coal hoists are provided, capable of tipping at any height up to 45-ft. from quay level. These appliances are movable to permit of two, or if necessary the four hoists being utilised for one vessel.

The North Dock has an entrance from the River Mersey 55-ft. wide, with berthing space 2,400-ft., and can accommodate vessels up to 290-ft. in length; there are ample hydraulic travelling cranes, a 40-ton electrical sheerlegs and four fixed high level 20-ton coal tips.

The Old Dock entrance from the Mersey is 50-ft. wide, the berthing space being 2,160-ft., and vessels up to 250-ft. in length can enter; the quayside equipment includes hydraulic travelling cranes and three fixed high level coal tips of 20-tons capacity.

Quayage Extension Works at Argentine Ports

By RAUL BUICH
of the Argentine Association of Engineers.

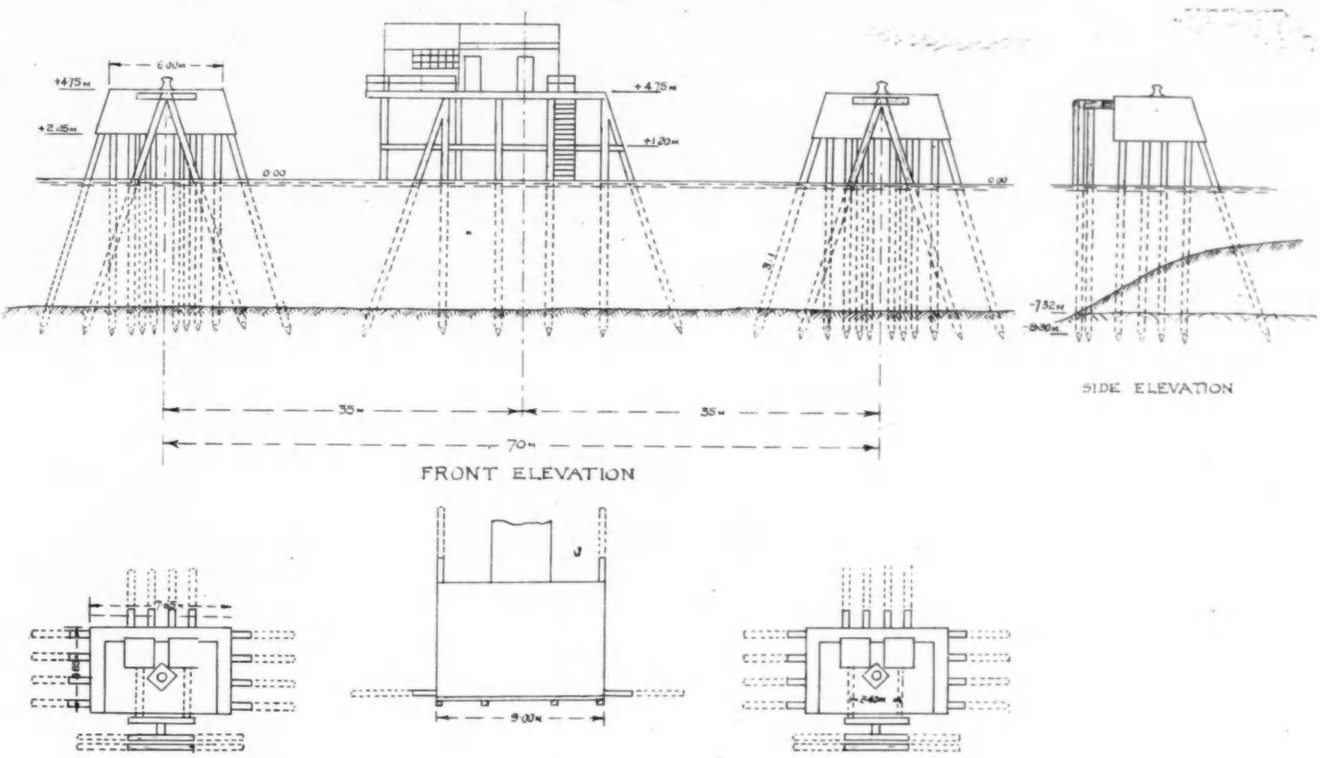


Fig. 1. Mooring dolphins for the fumigation centre in the Port of Buenos Aires.

I.—GENERAL DESIGN CONSIDERATIONS

IN the days of sail what we now term " ports "—that is, places laid out for the loading and discharge of cargo—were nothing more nor less than natural harbours maintained at the shallow depth then required and without any port works or repair facilities. Such were the original ports of Riachuelo de los Navios, of Ensanada de Barragan, Las Conchas, Tuyu and Patagones in the Province of Buenos Aires, and Corrientes, Diamante, San Pedro, Punta Gorda, etc., on the Parana; which, in their day, fulfilled every military and commercial need.

Progress in naval architecture created a profoundly chaotic situation in the unsatisfactory natural harbours of the country. Their shallow depth and small area were inadequate for the handling of cargo from larger vessels; loading and discharging were carried out in an inconvenient and disorderly manner, at high cost. Fraud and contraband, greatly favoured by such conditions, assumed such proportions that shippers themselves were the most interested parties in the promotion of port works to cope with expanding trade.

Our country is greatly blessed by nature, having 4,000 kms. of maritime coast and 3,550 kms. of river banks, taking into account only the rivers Parana, Paraguay and Uruguay for their navigable lengths. There are thus some 805 ports for which conservation, extension and improvement plans have been prepared; the magnitude of this work is conveyed by the fact that every year some 45 million Argentine pesos are spent on these works by the General Directorate of Ports and Navigation.

* Report of a Lecture delivered to the Argentine Association of Engineers, held under the auspices of the Technical Division of Ports and Navigation, published in the February, 1945, and following issues of " La Ingenieria"; translated and abridged by Rolt Hammond, A.C.G.I., A.M.I.C.E.

Some of our problems have already been brilliantly described by the distinguished colleagues who have preceded me in this series of lectures. For my part I shall deal with works built for the purpose of making contact between ship and shore, and will also refer to those devices which facilitate the construction of ports and are termed " dock works."

General Conditions for Satisfactory Dock Construction

The time spent by a ship in port depends not only upon the operations of loading and discharging cargo, but also upon a number of other equally important factors. During this period services must be provided, such as the means for adjusting and repairing machinery, and the supply of drinking water, food, fuel and lubricants. Since these operations must be completed in the least possible time and at minimum cost, it is desirable that as many as possible shall be carried out simultaneously; that is to say, without shifting the vessel in port. This implies the need for providing docks which shall be equipped with all the ancillary services, wherever it may be situated. The layout will have to satisfy the following requirements:

(a) Adequate depth of water alongside the quay walls to ensure flotation of vessels at all states of the tide.

(b) Mooring equipment—such as bollards and mooring rings—shall be strong enough to absorb the maximum load likely to be imposed by wind and current acting on the ship from any direction.

(c) The necessary winches, cranes and sidings shall be provided to handle all the cargo entering and leaving the port.

(d) In the case of tidal docks, similar moorings shall be provided, but with the necessary equipment to allow for the rise and fall of the tide.

(e) A complete ship service must be provided, both with regard to equipment and stores, in addition to facilities for maintenance works on hulls.

Quayage Extension Works at Argentine Ports—continued

(f) Both mooring and towing operations shall be possible with maximum safety and simplicity.

(g) Passenger companion ways should be of such a number and disposed in such a manner that for the smaller vessels they are complementary to the larger structures.

(h) Electric power lines, drinking water pipes, telephone lines and other services should be arranged in ducts.

(i) Special equipment, such as belt conveyors for loading frozen meat or grain, and oil ducts with connections for tankers, should be arranged with special attention to the functions which they are called upon to perform.

(k) Provision of a superstructure at a convenient height above water level to allow efficient operation of all the services during the period that the vessel is moored to the quay.

Dock Capacity

As we have seen above, there are many different factors to be taken into account when planning port works; they can be classified in two main groups, namely:—

sufficient capacity to accommodate the different installations; at any rate, accommodation of special type should be arranged in close proximity to the moored vessels. From these considerations we can determine whether there are to be dock walls or moles.

There are also intermediate cases, where natural conditions allow of the development of quay walls formed by pitched slopes. These may constitute the original works forming the basis of future extensions, or may be employed for special purposes, such as grain elevators.

Finally, there is a totally different type of development to those already mentioned, that is to say for those cases where there is a marked variation of water level or where the water is deep. The best solution for a tidal dock is a floating pontoon with a transfer bridge.

I shall consider the subject under three headings, namely:—

(a) Dock works of limited capacity.

(b) Dock works of an integral character.

(c) Dock works for natural sites, where conditions are extremely variable.

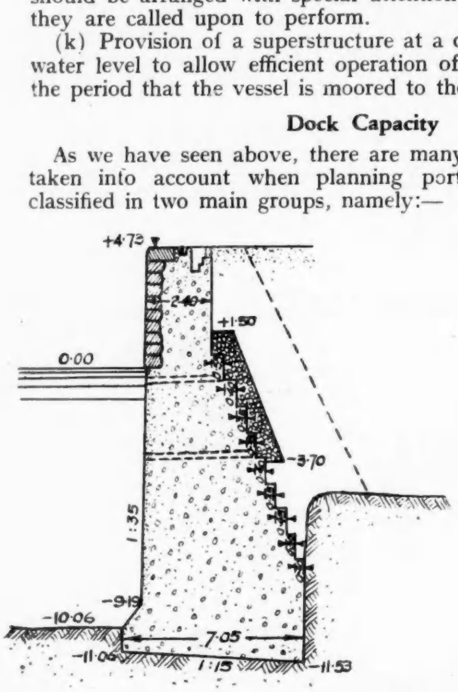


Fig. 2. Cross section of the wall built by Walker and Co., for the Port of Buenos Aires.

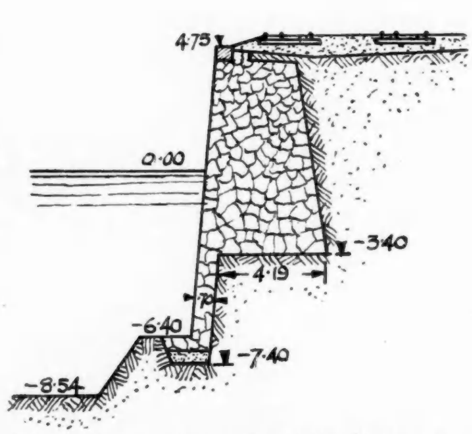


Fig. 3. Cross section of the original dock wall at the Central Dock, La Plata.

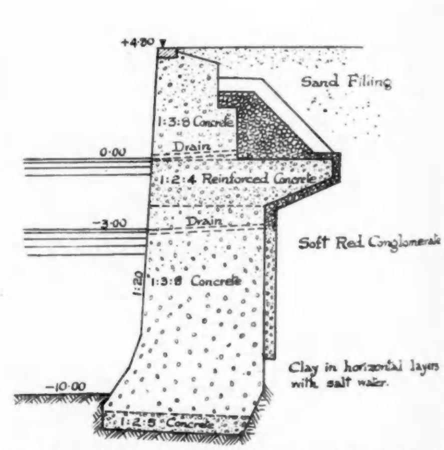


Fig. 4. Cross section of the reconstructed dock wall at the Port of La Plata.

(a) Works limited to the mooring of vessels and the provision of a few of the services detailed above.

(b) Works of a more extensive nature, affording all the equipment necessary to give full port facilities.

Works classified under the first heading are of comparatively small size, depending upon the traffic in the port and the depths of water available; these works can be sub-divided thus:—

(a) **Mooring Posts:** Comprising one or two mooring posts, with a sub-structure or " dolphin " for reaching solid ground.

(b) **False Quays:** Where it is necessary to develop adequate quayside facilities to satisfy the traffic in relation to the depth of water available.

(c) **Marginal Moles:** Provided where it is possible to give adequate depth of water at a short distance from the shore.

There are many variations of the last two types, according as to whether the mole is of the pier or quay design; whether it is possible to provide small sheds or service buildings; or whether, in the case of a quay, it is feasible to provide a railway siding. It can be appreciated, however, that works in this group can provide only limited port facilities; they are confined to the category of primary installations to deal with reduced volumes of traffic.

In certain ports it is necessary to provide not only the services mentioned above, but also to arrange large areas of ground adjacent to the dock works proper, planned in such a manner as to permit the layout of sheds and stores, roads, railway sidings and complementary services such as passenger stations, workshops and repair docks; finally, all these elements must be co-ordinated with the development of the dock works themselves. Such conditions call for the adoption of a layout of tooth form, with

General Dimensions of Dock Works

The following are the guiding factors in the design of port works:—

(1) Types and dimensions of the vessels using the port.

(2) Fluctuations of water level in the port.

(3) Soil conditions at the site of the works.

When we consider the extreme variation of all these factors for all the ports in this country, we can reasonably conclude that it would be a vain task to try and present a standardised solution. In fact, the wide variety of national trade on the one hand, and the import trade on the other hand, imposes—from a rational point of view—the employment of vessels of different types and dimensions. Thus we have transatlantic liners, general cargo vessels, fruit, sand, timber, coal, petrol, oil, meat and fishing boats, all requiring special dock facilities.

Furthermore, our extensive maritime and river coasts have metetorlogical and hydrological conditions which create special problems in each particular case. Thus, whereas in the River Plate at the Port of Buenos Aires the maximum variation of water level has exceeded 8 metres, it is more than 12 metres in the River Paraguay at Formosa and more than 14 metres in the River Uruguay at Concordia. There is also a wide variety in the nature of the sub-soil at our ports. In the valley of the River Plate we have alluvial soils with little or no bearing capacity; clay beds of greater or less depth, with a latent tendency towards slipping in the upper strata, are frequently found on the banks of the Parana; deep gravel beds at Nahuel Huapi, etc. These are but a few samples of the extreme variation in conditions with which we have to contend.

Quayage Extension Works at Argentine Ports—continued

The Design of Dock Works

The choice and dimensions of dock works for any particular port presents a very difficult problem for engineers specialising in this type of work; not only because of the ordinary difficulties of construction, but also because there is no common basis on which to determine the best solution both from a technical and economic point of view. This has been proved by all the classic works and papers presented to scientific meetings by specialists. In order to gain some useful information from the results of experience, we have studied—amongst others—the works of Quinette de Rochemont, Lo Gatto, Benezit, Bastiani, Cohen Cagli, etc. At the international congresses organised by the Association Internationale Permanente des Congres de Navigation in London (1923), Cairo (1926), Venice (1931) and Brussels (1935), the interest displayed in these matters was clearly demonstrated.

The bibliography resulting from all this work is in many respects insufficient to provide general rules for determining the most convenient type of dock work to provide the solution for any particular case.

The Design of the Dock Wall Section

The selection of the type of dock wall to be adopted depends upon the following factors:—

(a) Bearing power of the soil in the foundations.

(b) The possibility of carrying out the foundations in the dry or in trench.

(c) The amount of agitation due to water movements and the propagation of the reflected wave.

(d) Available plant and accommodation for workmen on the site.

(e) Development of the work; if this is on a large scale, then the employment of special plant and methods can be justified, with consequent benefit in the choice of a suitable dock wall section.

(f) Nature and cost of the materials available.

(g) Nature of the port installations for which the work is designed.

(h) Contractual time limit for completion of the works.

(i) Estimated contract time.

(j) Arrangement and size of the additional loads imposed by the dock installations.

II.—TYPICAL SOLUTIONS ADOPTED IN ARGENTINA TO CONFORM TO LOCAL REQUIREMENTS

A—Dock Walls of Limited Capacity

These works are of comparatively minor importance and only a few examples will be quoted:—

(1) Mooring Points for Servicing Tankers

This forms an integral part of the general plan for the building and equipment of a store for petrol and oil in the Port of Buenos Aires, in connection with which the General Directorate of Ports and Navigation has built the first dock for handling liquid fuel, comprising seven mooring posts of reinforced concrete having the following features:—

(a) Two specially made piles capable of absorbing the shocks of mooring.

(b) A supporting gantry for the oil pipe lines and subsidiary gear, such as valves, flexible connections and universal joints.

The main function of these works is to link up the storage depots in the immediate neighbourhood. Therefore the pipe lines can be reduced to the minimum size compatible with the nature of the fuel being handled; crude petroleum, fuel oil, refined petrol or kerosene will in each case require their special type of gantry.

(2) Docks for Car Ferries in the Ports of Lieutenant-General Jose F. Uriburu and Constanza

The type of structure adopted, in reinforced concrete, facilitates the mooring of the ferry at different levels of the river, without requiring any other transfer bridges than the short hinged ramp

Fig. 5. Piling gantry resting on the old wall.

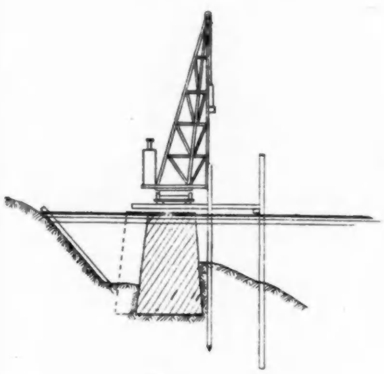


Fig. 6. Driving the inner and outer lines of sheet piling.

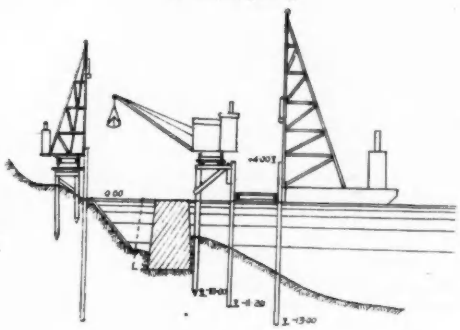
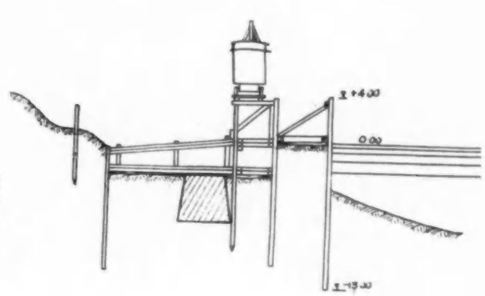


Fig. 7. Outer cofferdam completed, demolition of the old wall proceeding.



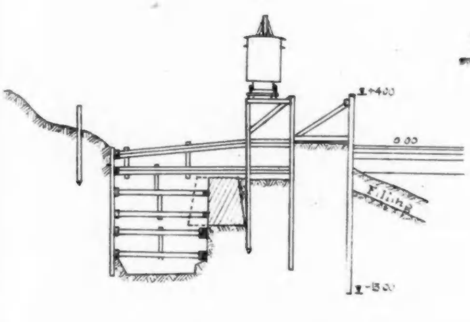


Fig. 8. Excavating foundations for the new wall.

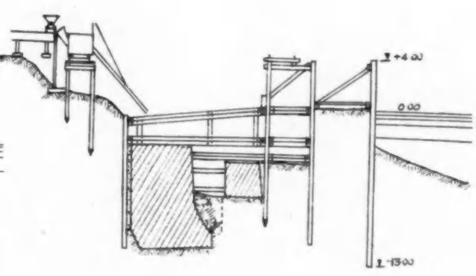


Fig. 9. Placing concrete in the foundation of the new wall.

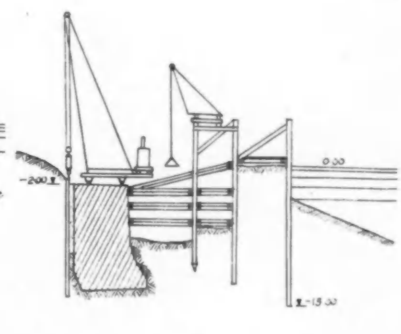


Fig. 10. Extracting the inner row of sheet piling.

Quayage Extension Works at Argentine Ports—continued

with which these ferries are provided. Four ramps have been built, with their levels at 2.21, 2.96, 3.71 and 4.46 metres above water level at different slopes; these docks have proved their value over a period of years.

(3) Fumigation Centre for Vessels in the Port of Buenos Aires

This work comprises two mooring dolphins and a centre access dolphin, spaced at 35 metres centre to centre, as shown in Fig. 1. There are two distinct structures on each of the two mooring dolphins, one rigid and the other elastic. The latter consists of two pairs of hardwood piles, joined at the top to a pair of rolled steel joists which in turn are supported by two pairs of joists set in the concrete superstructure of the main rigid portion of the dolphin. The shock loads from a vessel are transmitted through four steel springs each made of 40 mm. diameter wire, mounted on cylinders of 16 cms. diameter and anchored in the concrete of the dolphin on the shore side. By this means it is possible to absorb the kinetic energy of a vessel of 10,000 tons striking the structure at a normal speed of 20 cms. per second, in which case the static load transmitted to each dolphin will amount to 64 tons.

The rigid portion of the structure comprises a pyramidal concrete block supported by 26 piles of 35 cms. diameter each, ten vertical and the remainder inclined. Their resistance is sufficient to absorb a static load of 100 tons acting on the mooring bollard from any direction.

III—DOCK WORKS OF AN INTEGRAL CHARACTER

I will now describe works carried out in the National Ports in accordance with the following classification of typical dock wall sections:—

(1) Continuous walls of constant section.
(2) Continuous walls built of blocks.
(3) Walls with intermittent foundations.
(4) Walls built by means of floated caissons.
(5) Light structures and mooring moles.

(1) Continuous Walls of Constant Section

The adoption of any particular section for a dock wall is technically limited by the foundation conditions and by whether or not the footings are located at little greater depth than the dock in which the wall is constructed. It is also convenient to adopt a simple section in which large quantities of low cost concrete can be used, and wherever possible the wall should be constructed in the dry.

In those cases where walls have been built below water level, either by means of compressed air or by diving bell, the resultant cost has been very much greater than that of works carried out in the dry. Thus in the Port of Amberes the contract price for walls of this type was between 40,000 and 45,000 francs per lineal metre as against 16,600 francs per lineal metre for walls built in the dry.

In this country the construction of full section walls has been carried out exclusively in the dry and under the two following circumstances:—

(1) Within the excavated area of docks or basins, forming a boundary to the latter.

(2) Within sheet piling driven around the area in which the work is to be carried out.

Typical examples of the first type of work are provided by the dock walls of Puerto Madero and by the new Port of Buenos Aires; these works permitted both excavation and the construction of the dock walls to be undertaken in the dry.

Dock Walls for the New Port of Buenos Aires

In the course of planning the dock works for this port, authorisation for the work was granted by Law No. 5944 of 1st December, 1909, and twenty-seven surveys were undertaken by experienced contractors; finally, proposal "B" submitted by Walker & Co., was accepted and confirmed by Superior Decree dated 28th April, 1911. This company had previously undertaken the works at Puetro Madero. The total length of quay wall carried out was more than 5,500 metres and the approximate cost was about 5,000,000 Argentine gold pesos—apart from 3,000 lineal metres of sea defence works—at an average cost per lineal metre of some 2,050 Argentine paper pesos. With regard to the latter works, it should be noted that their existence is of benfit to the port as a whole. In whatever manner their cost is charged to the dock walls, the cost per lineal metre of the latter was raised to 2,460 pesos, considered to be a moderate increase.

A cross section of the wall adopted is shown in Fig. 2; it is of mass concrete, faced with nine courses of dressed masonry and having a masonry cope. The relatively large number of steps on the back face permitted concreting to be carried out in a simple manner; the concrete was a 1:3:8 mix, except on the face of the wall, where a 1:2:5 mix was adopted.

The varying depth at which a firm foundation could be found —from 5 metres to 7.5 metres below the datum shown on the section—led to the adoption of two different sections with a width at the base varying from 7.05 to 7.50 metres and having cross

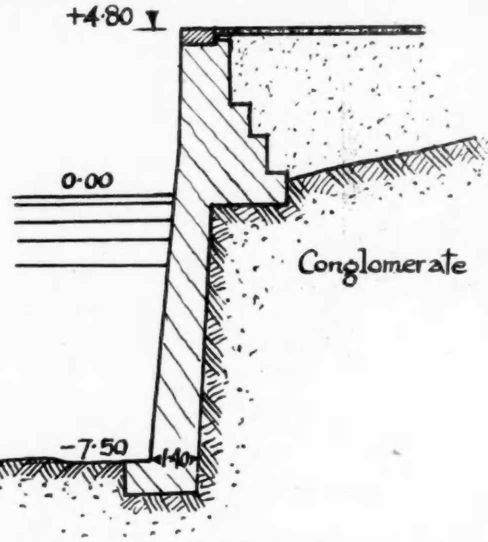


Fig. 11. Cross section of the sea wall at the Port of Quequen.

sectional areas varying from 70.50 to 72.50 square metres respectively. Calculation of stability has been based on the assumption that the water level would be lowered 2.50 metres below the local datum, which turned out later to be less severe than the fall of 3.63 metres in the water of the River Plate on 13th July, 1920. The maximum uniform load on the quayside was assumed to be 6,000 kgs. per square metre, and the maximum bearing strength of the sub-soil on which the wall was founded was taken as 4.87 kgs. per sq. cm., a figure subsequently found in practice to be reasonable.

It was later discovered that these loads were never imposed on the wall, because the natural angle of repose of the soil was at all times greater than the 45 degrees assumed, thereby reducing very considerably the pressure on the back of the wall. Thus the calculation of stability, using an angle of repose of 45 degrees, was well within the actual loading.

Large mechanical shovels were used for the excavation of docks and dock walls, the foundations for the latter being taken down to their final level by hand pick. A system of drains led all surface water to sumps, whence it was pumped in order not to affect the concrete. The concrete plant consisted of a Ransome mixer having a capacity of 30 cubic metres per hour of concrete, giving a production in eight hours sufficient to provide for four lineal metres of dock wall; the whole equipment was mounted on rails.

In view of the sound nature of the sub-soil, a considerable amount of shuttering at the back of the wall was eliminated in the lower portion; on the front of the wall the shuttering took the form of planking one metre high and two metres long. In a later modification of the construction method, the concreting plant

Quayside Extension Works at Argentine Ports
(continued)

was placed at the bottom of the dock, and a Temperley transporter was used for lifting the barrels of cement from one side and the mixed concrete from the other, thereby greatly accelerating the pace of the work. Expansion joints were arranged at distances of between 50 and 60 metres one from another, and were in the form of smooth shutters which could be easily removed after the concrete had set.

Construction of Walls in the Dry Within Sheet Piling

I shall now consider the two following works:—

(1) Reconstruction of the walls at the Central Dock of the Port of La Plata.

(2) Construction of the sea wall at the Port of Quequen.

Central Dock at La Plata

This work was undertaken between the years 1925 and 1929, in accordance with a contract placed with the Siemens-Schuckert Plate Electricity Company, S.A. (Siemens-Baunion Section), approved by Superior Decree dated 24th November, 1924. The original dock wall at the Central Dock had been constructed in the dry and had been partly founded on a cap of clay with chalk nodules, inaccurately described as soft conglomerate, the rest of the wall being supported by a concrete footing (Fig. 3). This form of construction resulted in an uneven distribution of pressure on the footings, the concrete footing being more rigid than the clay stratum.

Accidents which have occurred to this type of wall are easily explained by its construction, and the General Directorate of Ports and Navigation has on many occasions condemned this method. The reconstruction works carried out on the west bank and the cross-section adopted for the wall is shown in Fig. 4; the wall was built in the dry within a double cofferdam, at an average cost of 19,000 Argentine paper pesos per lineal metre. The process of construction is illustrated by the following sketches:—

Fig. 5 shows the piling gantry resting on the old wall, with the outer line of sheet piling driven to a level 3.80 metres above maximum flood level, and to a depth deemed to be sufficient for carrying out all the foundation works. In Fig. 6 is shown the driving of the inner line of sheet piling from a service gantry, and the outer line of sheet piling from a floating pile driver. Fig. 7 shows the outer double cofferdam completed and the beginning of the demolition of the foundation of the old wall; Fig. 8 is a further stage in the demolition work and in the excavation for the new wall.

In Fig. 9 we see the concreting for the foundation of the new wall, and note the excellent manner in which the timbering has been arranged. Finally, in Fig. 10 we see the piling gear extracting the inner row of sheet piles and the remaining portion of the old wall being demolished.

This new wall replaces the greater part of the wall on the west bank which had collapsed, and amounts to a length of 109 metres. Experience showed that a double cofferdam was needed and that the revised section of the dock wall was justified.

Sea Wall at Quequen

The sea wall at the Port of Quequen, a section of which is shown in Fig. 11, is remarkable both for its exceptional height and for the fact that the lower portion was of comparatively light section in view of the firm nature of the ground behind it. In short, this portion amounts to a thin protection wall, having a maximum thickness of 1.40 metres at the base. A total length of 300 metres of this section of wall was constructed on the north-east side of the port, two-thirds of the work being carried out by contract and the remainder by administration; the cost varied considerably with ground conditions, and ranged between 1,600 and 3,400 pesos per lineal metre, including ancillary works. The wall was built in stone masonry within sheet piling.

Tangku Harbour Project.

Construction work on the Tangku Harbour project is proceeding rapidly, and the new breakwater is expected to be completed before the end of the year. This work will permit vessels of large tonnage to enter the harbour and berth at the new wharves.

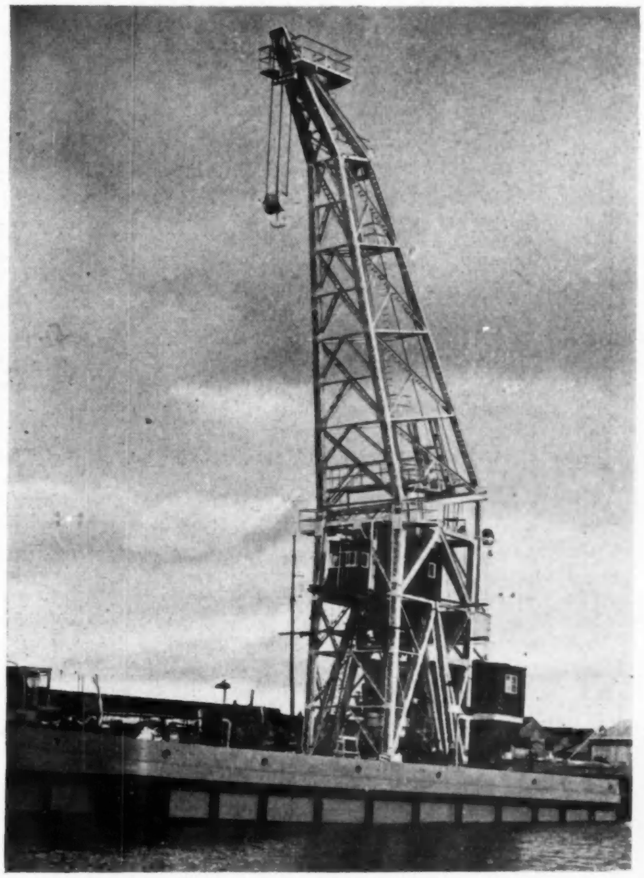
The Port of Melbourne, Australia

New Installation of Diesel-Electric Floating Crane

Supplementing heavy-lift cranes already in use in the Port of Melbourne, a diesel-electric floating crane with a lifting capacity of 40 tons has been assembled at North Wharf, Melbourne, by the Melbourne Harbour Trust.

The hook of the crane is 88 feet above the water. The pontoon weighs 380 tons and the crane mechanism 170 tons.

The various motions of hoisting, luffing and slewing will be carried out under power from electric motors supplied by a generator which is driven by a 300-horsepower diesel engine.



Built in two parts at the Melbourne Harbour Trust's new Williamstown shipyards, the crane was assembled by a fixed 60-ton steam crane.

Ship-side service by mobile heavy lift will be provided by this unit. It will be useful not only in handing heavy lifts from ships but also for fitting out vessels under construction or repair.

When handling full loads, the speeds of the crane will be: Hoist 20 feet a minute, luff 30 feet a minute, and slew one revolution in two minutes.

Electric capstans are provided on the deck of the pontoon for warping the crane alongside a ship to a position at opposite point from which lift is to be taken. An electric windlass will handle the three-ton anchor carried at one end of the hull.

The pontoon itself will be equipped with crew accommodation and amenities of modern design.

The approximate cost of the entire unit was £70,000.

Floating Dock for N.S.W.

The first all-welded floating dock to be built in Australia was recently tested at the Captain Cook Dock, Sydney. For the test, the dock, which normally will be required to carry a maximum of 1,000 tons, held an oil-laden lighter weighing 1,500 tons.

Review

Portuguese Port Developments

O Melhoramento dos Portoa Continentais e Insulares de Portugal a cargo da Direcçao Geral dos Serviços Hidraulicos. Pp. 50 with plans and photographs.

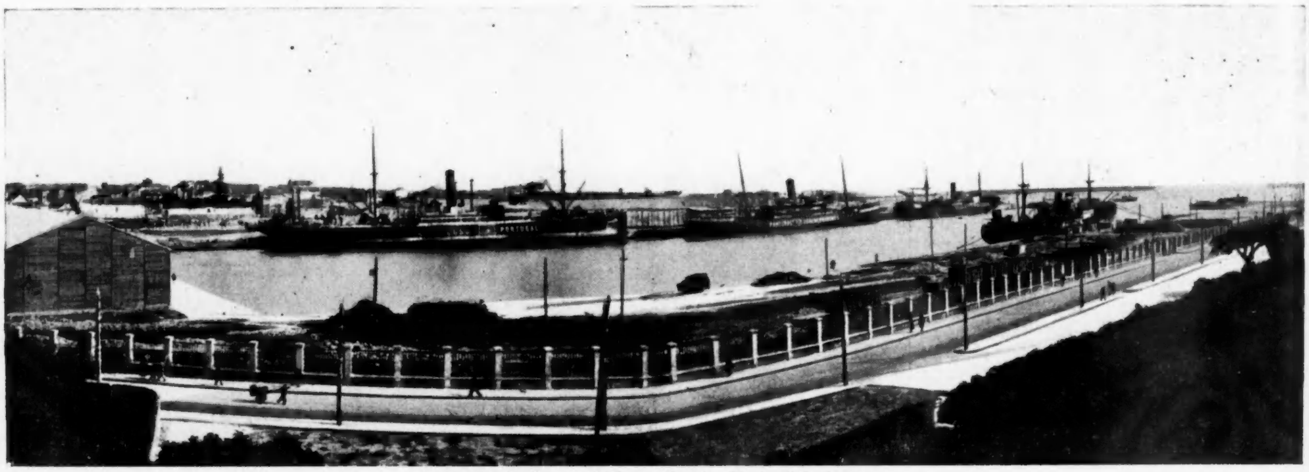
There has been received from the office of the Director General of Hydraulic Services, Lisbon, an illustrated brochure giving a detailed account of the improvements carried out at Portuguese ports within recent years and a statement in regard to the further works the execution of which is proceeding.

3. Considerable improvement in the condition and accommodation at the Port of Viana and a notable increase in its activities.

4. Construction of the principal defence works at the artificial harbour of Povoa de Varzian—the north breakwater, the south breakwater and the dock breakwater.

5. Sensible improvement of the conditions of accessibility to the harbour of Aveiro, without, however, attaining the complete improvement which is desired, but with a notable increase in the activities of the port.

6. Appreciable improvement of the conditions of accessibility of the harbour of Figueira da Foz, as proved by the actual permanence of its utilisation without definitely reaching the desired standard and despite some important local silting.



General View of No. 1 Dock, Port of Leixoes.

After setting out the various legislative enactments as far back as December, 1927, authorising the programme of proposals for the development of Portuguese ports on the mainland of Europe and the adjacent islands, the present position is summed up as follows. There is today in full operation a dredging maintenance service, and, at the point of completion the first instalment of port works called the First Phase, resulting in the following achievements.

1. Considerable expansion of the accommodation of the Port of Lisbon through the establishment of new deep water berthage with quayside equipment.

2. Re-modelling of the Port of Leixoes, which now possesses a capacious dock having magnificent quay frontage and deepened berthage, and, above all, it is relieved of the prejudicial condition of being a harbour which ships are advised to leave on the approach of storm, this being the result of a radical transformation of its internal shelter and of a notable improvement in its accessibility. There has been considerable increase in the activities of the port.

7. Establishment of works of commercial adaptation and for the fishery industry at the harbour of Setubal, in conjunction with the transformation of the aesthetic and sanitary conditions of the frontal margin of the city.

8. Various improvements at the harbours of Faro-Olhao and Vila Real de Santo Antonio, and important developments of the harbours of Funchal (Madeira) and Ponte Delgada.

The foregoing improvements have been carried out at a cost of a little more than 394,000 contos.

As regards the future, or what is termed the Second Phase of the port development programme, an enunciation is given of the basic principles governing the selection of the works to be undertaken and this is followed by a detailed notice of each of the ports concerned, with their possibilities of improvement of the conditions actually in existence. Among them special attention is given to the fishing ports with a view to their development in the interests of the industry and of the inhabitants engaged in it.

The volume is profusely illustrated and contains a great number of plans, diagrams and photographs.

Operating Safeguards for Modern Cranes and Loading Devices

By A. G. AREND

Operating safeguards used in the construction of cranes and loading devices generally, have been given greater attention of recent years not only with a view to minimising damage to machinery, but to prevent accidents which may involve the payment of appreciable sums for compensation. Comparisons of the losses of life in different industries have proved that explosive manufacture is one of the safest, because of the great precautions which are taken. The same cannot be said of coal mining which holds a relatively poor record, while dock and harbour activities one year averaged three accidents per 1,000 men engaged involving large payments in compensation. This, together with stoppages of work, injury to machinery, and greater need for maintenance, has resulted in a willingness to expend more on forestalling these troubles by introducing improved equipment. One of the greatest dangers to travelling loading bridges and cranes is storm, especially if it breaks suddenly, and with such violence that the crane or bridge begins to move, thereby causing accidents and damage which may be of an extremely expensive and disastrous character. While it may be relatively simple to secure effectively a loading bridge when stopped, by recourse to locking bolts, and clips, etc., a more complicated exigency arises when a non-secured bridge has been taken unawares (while travelling or operating) by a heavy squall. In such circumstances even the best of brakes may fail to stop a runaway bridge, or hold it on the spot. For this reason a safeguard has been introduced which never comes into operation in normal conditions of work, or while no particularly strong wind is blowing, but should this increase appreciably, immediately reacts. This occurs when, firstly, the wind increase is such that the bridge fails to stop within the prescribed time after the

Operating Safeguards for Modern Cranes and Loading Devices—continued

traversing gear has stopped, or secondly, when the bridge is at a standstill, and under the pressure of the wind commences to move. Brakes alone cannot be fully relied upon, for which reason a safeguard device, set for free travel, is provided for each bridge support. So long as the traversing gear of the bridge remains in contact, an electro-hydraulic brake lifter is also in live circuit, thereby lifting a weight so that a brake block is suspended above the rail, but this lifter ceases to be in circuit the moment the traversing gear stops. Accordingly this weight descends and makes the lined brake block bear down upon the rail, and the bridge cannot move any further. This is assisted by a wheel engaging in the bridge-leg which proceeds to the right or the left, and climbs the brake-block, thereby forcing it down on the rail with the full weight of the bridge for load. A damping device is included in the lifter mentioned, and this can be timed so that the brake-block will not reach the rail until the bridge has accomplished its normal slowing-down travel.

When the storm has abated and the wind has dropped, the bridge is then run back a little, whereupon since the lifter was thrown into circuit again by starting the traversing motor, the brake-block leaves the rail, and the bridge is again ready to travel in either direction.

Sanding Precautions

Although the use of sand-sprayers, which represents a further means of forestalling accidents, is quite familiar in the case of railway trains and trams which are still in service, the same cannot be said of many cranes, loading bridges, or other loading equipment which runs on rails.

When the brakes are applied, sanding causes an increase of friction between the rail and the tread of the wheel. In the face of imminent danger, this is particularly necessary so that braking can take place instantly. Slipperiness is caused not only by hoar-frost and rain, but by coal-dust, mist or fog.

The necessary prompt response is acquired by sanding in the appropriate manner with equipment which is easy to instal, and reliable even with remote control. This is done by a device which includes a magnetic tapper from which sands spills over in a steady stream. The sanding plate beneath the sand box is caused to vibrate during discharge for this purpose, and ensures this steady stream of sand dropping constantly into the sand-pipe which terminates just above the rail, and can be increased or diminished exactly as required. By depressing a push-button switch, the sand-sprayer is cut in, but regulation can also be inter-locked with the controller in such a manner that the latter, on reaching its braking position, automatically starts the sand-sprayer. There would be little point in having first-class braking systems if the best contact is lacking, yet not a few cranes and other loading devices which run on rails only possess at most an improvised form of sanding arrangement, which is not properly vibrated, or kept under strict flow control.

Covered Collector Lines

A further source of accident occurs with electrically-operated loading bridges, and slewing cranes, etc., because of the manner in which the power supply is transmitted. This usually comes from rails or trolley wires accommodated in channels along the side of the track, the channels or trenches having a slot along their whole length, broad enough to house the current collector rigging, which is fixed on the track to the vehicle. Only the more up-to-date arrangements have abandoned this lengthy slot which is always open, and the sides of which are made of concrete or steel sheeting. Accidents arise through attendants inadvertently stepping into the slot, also ropes and wires may penetrate into the interior of the channel, or lumps of material can get jammed into it. Recognising these practical difficulties, a slotless form of collector line channel has been evolved, where covering plates are engaged to seal the entire length of the slot. These are hinged together to form a continuous chain, while the current collectors are installed on a car which travels along between the channel sections, and is linked up to suit.

Besides the four running wheels, this collector car has four more wheels which raise the covering plates of the channel sufficiently far to allow the necessary passage underneath during travel. Since the pressure of contact with the collector line never varies, it is thus of no account if there is subsidence of the ground, or faulty work with the foundations. In view of the flexible link connection coupling the collector car to the crane, it is of no importance if there are differences in the distance between crane track and channel, either vertically or horizontally.

Modern Hook, Limit Switch and Tightener Devices

As a detailed account of the laminated hook has appeared elsewhere, its advantage in accident-prevention will only be dealt with briefly, since in any case, this is already comparatively established for modern heavy loading purposes. This hook comprises a number of separate leaves or plates which are made of the best selected steel, and should one happen to break, the remainder are more than sufficient to sustain the load. Not only this, but examination of individual plates is simplified, and replacements can be made without delay, while each lamination can be utilised to the full extent of its period of service. Ultimately, over-straining or fatigue takes its toll, and is seen in the form of fine cracks which indicate that a replacement is necessary. In order to furnish a good bed for the slinging ropes and chains, a liner block with crowned face goes inside the hook. This incidentally ensures that all laminations share the load equally, unlike the traditional system of using a solid hook. In place of the familiar screw shank, a locked ring journalled in ball bearings, holds the advantage of eliminating the screw end. Formally, this point was where cracks often developed, and the most dangerous feature is that there is no evidence on the surface of impending fracture until an accident has actually occurred.

From another aspect, when the hooks are in use, limit switches are included in the outfit so as to automatically cut off the current supply a little before the permissible hook travel has reached its conclusion. Whereas plain buffer stops suffice for crane and crab traversing gears operating at low speeds, similar limit switches for automatic stopping of the motors prior to reaching their end positions, is no less important should they travel at fairly high speed. Should there be negligence on the part of the craneman in over-running the highest permissible load positions, the hook or grab could crash into the hoisting gear, crane-frame or drum, etc., with attendant danger to all around. Wherever space is restricted, and where much work has to be done by the hook in topmost position, a very short re-setting distance is invaluable. It is here with the limit switch that when the hoisting gear has to be restarted in reverse direction only one 120th part of the total lift need be traversed for renewed action to give the desired response. Greater safety in the event of hooks pulling on a slant is obtained where a rope guide and tightener is used, so that the load rope winds up evenly, and never remains tightly wound around it, while also preventing a slackening of the rope.

Without this device, the rope is apt to creep back on the drum when without load, and could jump the grooves.

This is obviated by the rope tightener comprising a threaded gun-metal ring surrounding the entire drum like a nut, and moving to right or life as the drum revolves, and simultaneously taking along a tightening ring, and being provided with a tightening screw.

In conclusion, this brief account will give some indication of the pains which have been taken to forestall accidents, not only because of humanitarian considerations, but because of the excessive expenditure on compensation, stoppages and non-observance of times of rapid delivery, besides damage to the mechanism. By installing safety devices, at rush periods the labourers can devote themselves unrestrictedly to their duties without risk, and offer least concern to the management, while giving greater confidence to those in the connected transport lines.

Change of Address.

Messrs. Butters Bros. & Co., Ltd. announce that their London Office has been removed from the wartime address at Wimbledon to central premises at Trafalgar House, Waterloo Place, London, S.W.1. The new telephone number is Whitehall 8654.

Australian Notes

(By our Australian Correspondent).

Mr. H. H. Styants, M.L.A., in his capacity as Chairman of the Royal Commission to enquire into the better use of Western Australia's outports, has been making enquiries into facilities for handling cargoes by visiting Sydney, Melbourne and Adelaide, and is discussing the question of appointing one authority to control all the ports of Western Australia. At present there are three controlling authorities, the Fremantle Harbour Trust, the Bunbury Harbour Board and the State Railway Department (controlling Esperance, Geraldton and Albany). The system of control in New South Wales, is based on the Maritime Services Board, which controls all the ports in the State from a shipping point of view, and all the work in the Port of Sydney. Outside Sydney, however, work is controlled by the Public Works Department. Victoria has the Melbourne Harbour Trust controlling the Port of Melbourne only, with control of other ports in the hand of various authorities, while South Australia has one authority only, the South Australian Harbour Board.

The Maritime Services Board of N.W.S. has no financial autonomy, money being handled by the State. Melbourne Harbour Trust has complete financial autonomy, and the South Australian Harbour Board has its money voted by the Government, and is allowed to spend no more than £5,000 on any class of work without Ministerial approval. This approval covers expenditure of from £5,000 to £30,000, but work over that value has to be approved by Parliament's Public Works Committee.

Fremantle uses a number of mechanical devices on its wharves, while Sydney is content to use little or no mechanisation, relying almost entirely on ship's gear. Port Adelaide uses a moderate amount of mechanisation, but still uses horses to haul cargoes from wharves to stowage and sorting sheds.

GREENOCK HARBOUR TRUST.

MOBILE CRANES FOR SALE.

The Trustees of the Port and Harbours of Greenock have for sale six (6) Petrol Electric Mobile Non-Slewing Cranes to lift 18 cwt. at 12ft. 9in. minimum radius and 12 cwt. at 20ft. 3in. maximum radius; Wheel Base 6ft. 9in., Wheel Centres 4ft. $10\frac{3}{8}$in. and 2ft. $1\frac{5}{8}$in respectively; 4 Cylinder, 24 H.P. Ford Industrial Engine.

The Cranes, whilst in general use within the Port during the war, were well maintained under a Makers' Inspection Contract, and have since been given a complete overhaul. The Machines are by Ransomes & Rapier, built and delivered in 1940.

Delivery of the Cranes to be taken on the site at the James Watt Dock, Greenock, where they can be examined by representatives of prospective buyers by arrangement with the subscriber. Offers, marked "Mobile Cranes" should be lodged with the Undersigned not later than noon on Monday, the 30th September, 1946. The Trustees do not bind themselves to accept the highest or any tender.

DONALD SMITH,
General Manager and Engineer.

Harbour Offices,
GREENOCK,
15th August, 1946.

GOVERNMENT SURPLUS STORES.

THE MINISTRY OF SUPPLY has for immediate disposal the following Portal Wharf Cranes located as shown below:

S/US/221/68/2-4. Three $3\frac{1}{2}$ ton Diesel driven portal wharf cranes. To lift $3\frac{1}{2}$ "short" tons at 60ft. maximum radius, from 30ft. below to 70ft. above rail level, at 200ft. per min. Mounted on four 2-wheel bogies at 20ft. longitudinal centres, to travel on rails at 15ft. centres. Power unit: Caterpillar D.1300 Diesel engine developing 120 B.H.P. at 970 R.P.M. to operate hoist, luff, slew, and travel motions. Fitted with $1\frac{1}{2}$ K.W. Kohler lighting set, and with crane spares, tools and three floodlights. Crane Nos. 8087-9. NEW AND UNUSED.

S/US/221/68/5. One crane as above but incomplete. Portal cap (or truck) is not available (includes lower slewing roller path slewing rack, part of travel transmission machinery and gearing). Crane No. 8086. This crane may not be exported to the U.S.A.

The above cranes are dismantled and packed for shipment in good condition. Maker: The Marion Steam Shovel Co. Location: Ministry of Supply Depot, Newbury Racecourse, Newbury, Berks. For inspection apply in writing to the Superintendent at that address, and quote report No. 3, Sheet 10.

Facilities are not available for working or load tests.

Purchasers must take delivery as and where lying and accept responsibility for removal from site within two weeks of the date of issue of Release Instructions.

Offers for any or all of these items are invited. No Forms of Tender are necessary and letters should be addressed to:—

Ministry of Supply,
Director of Contracts,
Great Westminster House,
Horseferry Road,
London, S.W.1.

To arrive not later than 10 a.m. on 23rd September, 1946. Envelopes to be marked "Tender No. 151501 returnable 10 a.m., 23rd September, 1946." Failure to mark the envelope correctly may result in a Tender not being considered.

Any Contracts made as the result of this tendering will be subject to the Department's usual Conditions of Sale (Form C.C.C./Sales/1), a copy of which may be obtained, if desired, from the Ministry of Supply, Contracts Directorate (C.B.4), Great Westminster House, Horseferry Road, London, S.W.1. Reference 151501 should be quoted when applying for this Form.

THE MINISTRY OF SUPPLY has for immediate disposal the following Cranes located as shown below:

S/49/25/5-8 (3344/1) 795. Four Morris Single Girder overhead cranes. 10-cwt. capacity rail centres 15ft. 8in., 4 lifting beams, 4 gantries for cranes 33ft. 9in. long, 4 spare steel load chains for cranes. Floor Control. Cranes in unused condition, components packed in export cases. Location: Maker's works, Loughborough. For inspection apply Mr. Barton at Loughborough. Telephone Loughborough 3123.

S/471/21/13 (3085/1) 835. One Liner Concrete Machinery Power Portable Giraffe Crane, 8-cwt. capacity, mounted on 4 wheels and fitted with tow bar. In fair condition. Located M.O.S. Store King's Newton Melbourne, near Derby. For inspection apply to Mr. Makepeace at King's Newton. Telephone: Melbourne 247 Ext. 5.

Arrangements for inspection can be made by prior application to the addresses named, but no undertaking is given that facilities will be available for working or load tests.

Purchasers must take delivery as and where lying and accept responsibility for dismantling (if necessary) and removal from site within two weeks of the date of issue of Release Instructions.

Offers for any or all of these items are invited. No Forms of Tender are necessary and letters should be addressed to:—

Ministry of Supply,
Director of Contracts,
Great Westminster House,
Horseferry Road,
London, S.W.1.

To arrive not later than 10 a.m. on 23rd September, 1946. Envelopes must be marked "Tender No. 145601 returnable 10 a.m. 23rd September, 1946." Failure to mark the envelope correctly may result in a Tender not being considered.

Any Contracts made as the result of this tendering will be subject to the Department's usual Conditions of Sale (Form C.C.C./Sales/1), a copy of which may be obtained, if desired, from the Ministry of Supply, Contracts Directorate (C.B.4), Great Westminster House, Horseferry Road, London, .SW.1. Reference 145601 should be quoted when applying for this Form.

THE MINISTRY OF SUPPLY has for immediate disposal the following Heavy Lifting Quay Cranes, located as shown below:

S/200/13/1-2. Two 110 Ton fixed steam cranes to lift 110 tons at 5-ft. per minute from 21-ft. below base to 39-ft. above base. Change speed gear to lift 30 tons at 15-ft. per minute. Luffing range from 45-ft. maximum to 7-ft. 6-in. minimum, outreach in 10 minutes with full load or in 5 minutes with 30 ton load. No slewing motion. Powered by two 2-cyl. (8-in. x 12-in.) steam engines each with verticle multitubular boiler, 150 lbs. per sq. in., 1,750 lbs. per hour. Weight 150 tons each. Cranes unused and dismantled. Available with spares and special slings, etc. Maker:—Cowans Sheldon 1943-3 Location. North Side Workington Dock. Application for inspection to be made in writing to Manager, Workington Harbour and Dock Board, Dock Office, Workington.

Purchasers must take delivery as and where lying and accept responsibility for removal from site within four weeks of the date of issue of Release Instructions.

Offers for these items are invited. No Forms of Tender are necessary and letters should be addressed to:—

Ministry of Supply,
Director of Contracts,
Gt. Westminster House,
Horseferry Road,
London, S.W.1,

to arrive not later than 10 a.m. on 23rd September, 1946. Envelopes must be marked "Tender No. 221701, returnable 10 a.m., 23rd September, 1946." Failure to mark the envelope correctly may result in a Tender not being considered.

Any Contracts made as the result of this tendering will be subject to the Department's usual Conditions of Sale (Form C.C.C./Sales/1), a copy of which may be obtained from the Ministry of Supply, Contracts Directorate (C.B.4), Great Westminster House, Horseferry Road, London. S.W.1. Reference 221701 should be quoted when applying for this Form.